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ABSTRACT

The theme of the 32nd International Association for the Development of Computer-Based Instructional Systems (ADCIS) Conference was "Restructuring Training and Education through Technology." This collection of conference presentations contains 52 papers and 183 abstracts for which there are no formal papers. The papers and abstracts are presented in two separate sections, but both are categorized by special interest group: (1) Academic Computing (SIGAC, 1 paper, 11 abstracts); (2) Computer-Based Training (CBT, 3 papers, 27 abstracts); (3) Elementary, Secondary, Junior College Educators (ELSECJC, 3 papers, 17 abstracts); (4) Emerging Technologies (SIGET, 5 papers, 10 abstracts); (5) Educators of the Handicapped (SIGHAN, 2 abstracts); (6) Health Education (SIGHEALTH, 2 papers, 9 abstracts); (7) Home Economics Consortium (HOMEC, 3 papers, 5 abstracts); (8) Hypermedia (SIGHYPER, 5 papers, 18 abstracts); (9) Interactive Video-Audio (SIGIVA, 7 papers, 19 abstracts); (10) Management Issues (SIGMI, 1 paper, 9 abstracts); (11) Music Education (SIGMUSIC, 1 paper, 4 abstracts); (12) PILOT Users Group (PILOT, 1 paper, 3 abstracts); (13) PLATO Users' Group (PUG, 4 abstracts); (14) Theory and Research (SIGTAR, 15 papers, 38 abstracts); and (15) Telecommunications (SIGTELE, 5 papers, 7 abstracts). Many of the papers include abstracts and or references. (DB)

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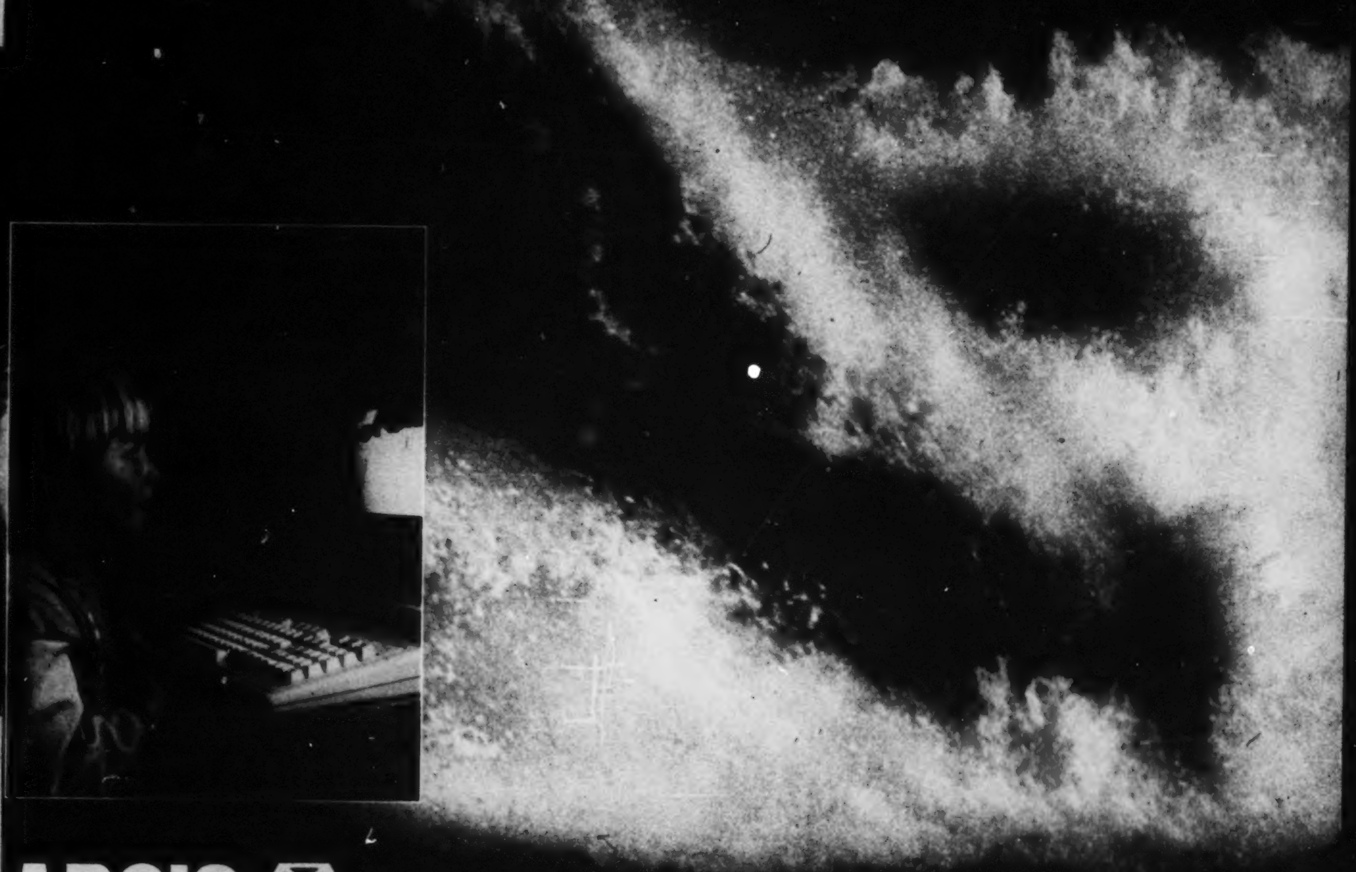

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Selected Abstracts for the

Special Interest Group for Academic Computing (SIGAC)

COMPUTER INVENTORIES ARE VALUABLE BENCHMARKS

Elisabeth M. Craig, The University of Tennessee at Chattanooga

A benchmark, called an Inventory of Courses Utilizing Computers in the Curriculum, has been published on an annual basis since 1976. This Inventory catalogs important shifts in computer usage, reports on departmental utilization, and summarizes information from current and previous years for comparison. The presentation describes the Inventory for those interested in replicating it.

Since 1976, our Academic Computing Services has published annually a benchmark called the Inventory of Courses Using Computers in the Curriculum. Academic departments are surveyed and provide data on courses which use computers, the number of students, hours of usage per week, the computer system (mini or micro) and type of usage in the course, i.e., statistical packages, simulations, problem solving, etc.

The inventory lists each course information, sorted according to department. There are eleven summary tables which show the results from other years plus the current one for comparison purposes. The summaries also show computer usage by department, system and microcomputer laboratory.

These inventories are valuable benchmarks for documenting the growth of computer usage within courses and clearly indicate the switch from mini to micro usage over the past ten years. Outside consultants have commended us on the information and its concise format. Also, the inventory was an important source document for a recent strategic planning task force on academic computing.

Over the years, we have discovered how to make data collection for the inventory as effortless as possible. The presentation discusses the format used to collect and analyze the data and presents examples of the departmental and summary tables. This is a "how to" presentation for those interested in developing their own inventory.

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INSTRUCTIONAL COMPUTING LABORATORY PROJECT

David W. Dalton, Kent State University

The Instructional Computing Laboratory Program (ICL) has as its principal mission, the design, development, and implementation of large-scale, integrated computer-based instructional systems, specifically, computer-based alternatives to conventional course delivery systems. The ICL houses five major concurrent research and development projects. The purpose of this session is to detail the goals and activities involved in each of the ICL projects to date.

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TECHNOLOGICAL SOLUTIONS: FACULTY + INSTRUCTIONAL DESIGNER = HIGH-QUALITY PRODUCT

Carol A. Dwyer, Pennsylvania State University

While academic computing professionals debate whether the best software for higher education is developed by a team or alone by a faculty member, we may be ignoring the fact that many faculty will not get involved in software use and development without some form of support. Acknowledging cost, time factors, and the difficulty of the content expert in conveying the content and pedagogical expectations to the team, more faculty will become users of instructional technology if they have assistance in locating, evaluating, and integrating instructional software. If a goal within higher education institutions is to encourage faculty to use interactive instructional technology, advantages and disadvantages of a support team should be considered.

The Center for Academic Computing (CAC) of Penn State provides broad support services to faculty, staff, and students. Within the CAC, CBEL—The Teaching and Learning Technologies Group has as its mission to support and empower faculty in the use of interactive technologies in teaching and learning. In cooperation with faculty, CBEL has developed instructional applications in many disciplines, including Mineral Science (Crystallography), Education (Teaching of Reading), Political Science, Agronomy (Weed Identification), and Foreign Languages. Teams consisting of content experts, instructional designers, programmers, and graphic artists combine their expertise to develop high-quality products.

Benefits of team-based design include development by more faculty, product quality, clarity, consistency, and completion of useable products. Some of the inefficiencies of team-based development include cost, slow start up time, and difficulty of project management. The presentation will include demonstration of several instructional applications, while highlighting problems and solutions unique to each project.

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LESSONS LEARNED WHILE DEVELOPING A UNIVERSITY ACADEMIC COMPUTING PLAN

Peter C. Issacson, University of Northern Colorado

While developing an academic computing plan for the University of Northern Colorado over the last two years, much effort has been expended and many lessons have been learned. The process of determining the problems and needs, establishing the recommendations, completing the plan, and utilizing computer tools will be chronicled. Practical suggestions from the experience will be highlighted.

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HYPERCARD IN HIGHER EDUCATION: SUCCESSES, CHALLENGES, AND STRATEGIES FOR USE

Annette Lamb, University of Toledo

HyperCard has become a popular tool for educators. This presentation describes the successes, challenges and strategies for incorporating effective uses of hypermedia technologies into higher education. It begins with a discussion of new technologies and reluctant technologists. It then focuses on current and projected uses of these technologies in higher education and describes obstacles in terms of personnel and funding. HyperCard applications in higher education are then discussed. Specifically, the use of HyperCard for the development and delivery of desktop presentations, tutorials, and information exploration-based instructional materials is discussed. Successes and challenges facing incorporation of hypermedia are described within the context of The University of Toledo. Sneaky and not-so-sneaky strategies for change are then highlighted, followed by a vision of the future of hypermedia in higher education.

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INSTRUCTIONAL DESIGN FOR COMPUTER-MEDIATED COMMUNICATION

Maurice Mitchell, University of Nevada System Computing Services

Computer-mediated communication (CMC) seems to be the latest fad in the use of computers in instruction. Recent activities in public education have highlighted the technology. U. S. Office of Technology Assessment reports include sections on CMC. The proponents of the National Research and Education Network are actively advocating the use of the NREN for CMC in instruction. FrEdMail and KIDSNET have fired up teachers in the K-12 schools about the value of CMC in their curricula. Faculty in higher education have engaged in computer conferences to investigate the value of CMC for instruction in higher education.

Much of the early use of CMC was ad hoc and haphazard in design. However, as CMC has grown in popularity faculty who embrace it are beginning to ask questions about how to use CMC to improve the instructional experience. Faculty who wish to try CMC for the first time are looking for guidance. While some guides have been produced to assist K-12 teachers, little has been gathered for faculty in higher education. This session will review a simple design guide for using CMC in instructional situations in higher education.

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AUTHORING TEMPLATES IN PILOT: ASSISTING MORE FACULTY WITH FEWER RESOURCES

Barbara A. Polka and Marilynne W. Stout, Pennsylvania State University

Faculty support units for instructional software development have limited full time staff to support an exploding interest among faculty members. Penn State's Computer Based Education Lab (CBEL) uses some unique approaches to solve this problem--Authoring Templates is one. Demonstrations of faculty courseware developed using PILOT templates and discussion of the success and pitfalls will complete this presentation.

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AN UPDATE ON THE MODEL CLASSROOM PROJECT AT PENN STATE

Lawrence C. Ragan, Pennsylvania State University

The "Model Classroom" project was designed to create an exemplary model of how computer technology could be integrated into the classroom. This project is a cooperative effort between several units at Penn State, including the Center for Academic Computing, the College of Agriculture, and the Computer Based Education Laboratory-The Teaching and Learning Technologies Group with support from Apple Computer Inc. The course selected to demonstrate this state-of-the-art use of technology is Animal Science 1, an introductory course for agriculture majors.

The project consists of three major phases:

- Phase I: Instructional Materials Development and Delivery
- Phase II: Student Support Materials
- Phase III: Lab Exercises and Simulations

This presentation will provide an update on the "Model Classroom" project initiated in 1989 at Penn State. Aspects of implementation and an evaluation of Phase I will be discussed including modifications and adjustments. Courseware presentation software developed for the project will also be demonstrated. Progress and plans for Phase II and III will be introduced. Discussion among participants will be encouraged focusing on problems and solutions encountered in similar experiences.

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100% OF EMPIRE STATE COLLEGE FACULTY ARE INVOLVED IN COMPUTING: THIS IS HOW WE DID IT

Carol A. Twigg, Empire State College

Many colleges and universities are interested in integrating computing and other technologies into the curriculum, but frequently they encounter resistance or disinterest on the part of faculty. No matter how dazzling the technology, no matter how promising the pedagogical potential, no matter how interested the students--when it comes to academic computing, if you can't get the faculty to use the technology, the rest is just talk. Developing successful strategies to engage college faculty in using computing is the key factor in achieving a flourishing academic computing program.

SUNY/Empire State College has engaged 100% of its full-time faculty in computing. This presentation will share strategies that have worked at ESC, including 1) make getting computers into faculty hands the number one a priority; 2) create critical mass of users at each stage of development; 3) don't worry about uneven development-encourage it; 4) don't worry too much about the particulars of computer use-just be glad they're being used; 5) create and support applications that people can use easily and that meet real needs; 6) don't be afraid to try stuff even if it fails; 7) standardize hardware as early as possible and software when people are ready for it; 8) provide as much training and support as you can manage, but realize that it's never enough; 9) engage in a constant internal public relations campaign; and 10) try to ignore the complaining.

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THE MARYLAND NUCLEAR SCIENCE BACCALAUREATE DEGREE PROGRAM: ON-SITE, ON-LINE, ON-TIME

Marcia A. Whitney, Thomas A. Janke, University of Maryland; and J. Robert Mueller, Wisconsin Public Service Corporation

The country's largest nuclear science baccalaureate degree program is delivered through computer by the University of Maryland to over 700 students at 8 nuclear utilities in 12 sites. The panel will discuss and evaluate the program from three perspectives: 1) developing multimedia courses for the adult, 2) administering a multimedia degree program, and 3) incorporating education on-site in a nuclear utility.

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INSTRUCTIONAL COMPUTING STRATEGIES: CREATIVITY ON CAMPUS

Laura Yordy, University of North Carolina at Greensboro

Given a low budget, how can we promote, coordinate, and assist the development and/or implementation of creative instructional computing in a university setting? Several strategies will be discussed, including: "seeding" the campus with low-risk, high-visibility projects, establishing grants for beginning faculty projects, organizing users' groups, and sponsoring project exhibitions.

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Selected Abstracts for the

Special Interest Group for Computer-Based Training (SIGCBT)

METHODOLOGIES FOR DESIGN AND PRODUCTION OF CBI

CBI is recognized to have a great potential. But often the potential is not completely realized. There are two major reasons for this. One is the fact that CBI implies a learning scenario which is different from the one involved with classical media. Therefore, the design of the interaction between the learner and the technology should be thought of on the basis of strategies brought to bear by the learner.

The second reason is bound to the production of CBI itself. The production process of CBI entails a coherence between three facets. The instructional design, the computer implementation and the marketing analysis. Very often, one or sometimes two of these facets are underestimated or not worked out with in depth analysis. If any of the three components are partially left out, no real coherence can be obtained. For instance, the product may be well designed and adequately implemented, but the analysis of the end-user's profile may be meager.

The objective of the Project Start Up of the European Community is to make an in-depth analysis of the design and production process of CBI in order to build a methodology within which total coherence between the three aspects can be obtained. This analysis relies in particular on strong considerations of the specificity of the learning scenario involved in CBI.

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ERGONOMIC CBT

Kay Bonham, Goal Systems International

Ergonomics is a design philosophy that considers various aspects of usability. For example, efficiency, ease of use, and comfort level are central ergonomic principles. This session describes ergonomics and explains how sound ergonomic design principles can be applied specifically to the design and development of quality computer-based training.

This session will analyze the usability of everyday objects to illustrate the importance of ergonomic principles in the design process. It will describe a systematic ergonomic design procedure and will compare this procedure to the CBT development process.

This session will also discuss the benefits of using ergonomic design principles in CBT development and the problems that arise from not following ergonomic principles. It will encourage participants to apply an ergonomic approach to various phases of the CBT design process, from how to accommodate diverse learning styles to how best to present information on the screen.

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AN EXAMPLE OF A COOPERATIVE EFFORT BETWEEN INDUSTRY AND ACADEMIA

Jerry L. Brown, Hewlett-Packard Company; and Emile Attala, California Polytechnic State University

This presentation describes a cooperative activity between business and academia in which courseware for teaching transmission line fundamentals was created. The interaction permitted educational computing students at Cal Poly to work on a "real world" training program while giving HP technical experts an opportunity to learn how to design technical training for delivery using the computer. Both institutions benefitted from the experience and are looking forward to continued cooperation. The presentation will describe the collaborative process used, and it will discuss the lessons we have learned from our joint activity. These should be useful to others looking to establish cooperative arrangements between industry and higher education.

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SOMETIMES THE MOST COST EFFECTIVE TRAINING IS...NO TRAINING

Charles C. Buchanan, United Airlines

Most of us have training as a part of our job or department title. If not we believe that training is a big part of our contribution. This perception may limit our proposed solutions to human performance deficiencies.

When we change our perceptions from training to improving performance suddenly more options are available. One of those options is a Performance Support System. People can be more productive, sooner when provided with a Performance Support System instead of training. This presentation reports on the United Airlines/Apple Computer Joint development project to prototype such a system for United's Maintenance Operations Division.

There are several critical elements to performance support:

- Design of materials
- Effective user navigation
- Workplace accessibility

Technology is releasing us from the constraints of traditional learning concepts. We can accommodate on demand, learner controlled materials if we try. There is a natural learning model, the way people learn when they aren't even trying, that can be applied to learning materials design.

We can accommodate learners by providing easy to use methods allowing them to organize their experiences the way they see fit. We can select cost effective delivery that allows access at the job site, wherever it may be.

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COMPUTER-BASED INSTRUCTION FOR TEACHING ENGLISH AS A SECOND LANGUAGE IN TAIWAN

Lih-Juan Chanlin and Thomas C. Reeves, University of Georgia

This study presents the status of CBI and IVD for teaching English as a second language (ESL) in Taiwan, and provides recommendations for further development. The instructional capabilities of interactive approaches are contrasted with the rudimentary instruction of existing ESL programs. The power of interactive materials to reflect traditional Chinese values (family, respect, obedience, loyalty, morality, and industriousness) is stressed.

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COMBINING ACCELERATED LEARNING AND COMPUTER-BASED LEARNING

Frank Clement, Boulder Center for Accelerated Learning; and Chuck Buchannan, United Airlines

Accelerated Learning (AL) is rapidly making an impact on corporate training and, at a slower pace, on primary education. Initial reports indicate an increase of learning of 35-50% and a reduction of learning time by 40-66%. The combination of AL and computer-based learning (CBL) holds significant promise of even greater gains. This presentation will discuss how AL and CBL can be combined.

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IMPLEMENTING THE ADVANCED QUALIFICATION PROGRAM (AQP) FOKKER-100 (F-100) PILOT TRAINING AT AMERICAN AIRLINES

Angela G. Coburn and Janet A. Wise, American Airlines

Pilot training is a priority facet of the airline industry. Recently, the Federal Aviation Administration (FAA) approved the development of proficiency-based pilot training curriculums rather than fixed-length pilot training curriculums under the authority of SFAR 58 known as Advanced Qualification Program. Current pilot training methods differ substantially from the proposed AQP which leans heavily toward ISD methodology. American Airlines intends to develop the F-100 pilot training as an AQP curriculum.

The AQP curriculum will include computer-based training (CBT), simulations, and part-task trainers, as well as instructor-based training. The curriculum is developed by first performing a thorough analysis of each task the trainee must master in order to become proficient in operation of the airplane. This is a monumental undertaking by any standard.

The linkage that will be established in the training based upon ISD principles lends itself greatly to the use of a comprehensive automated system. American Airlines is developing such a system based on relational database configurations that will facilitate the analysis, design, and development phases of the AQP pilot training curriculum. We will present a description of the methodology to be utilized in implementing the AQP with an automated system and the results of the implementation process that have been completed by October 1990.

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EVALUATION OF AN INSTRUCTIONAL DESIGN WORKSTATION AT MULTIPLE SITES

Kent L. Gustafson and Thomas C. Reeves, The University of Georgia; and Alberta Wray, Apple Computer

ID Library (IDeaL) (formerly called IDioM) is a software package for the Apple Macintosh environment that provides a comprehensive information base regarding a systematic instructional design (ID) model plus an extensive set of computer-based tools to support the ID process (Gustafson & Reeves(1990) IDeaL was originally designed for in-house use at the Training Support department of Apple Computer, Inc. This presentation reports the findings of a comprehensive beta test and evaluation of IDeaL at six external sites.

The evaluation addressed the following seven questions: 1) Does IDeaL work as designed?; 2) Is IDeaL a valid support system for instructional design in training contexts outside Apple?; 3) How long does it take to learn to use IDeaL?; 4) How easy is IDeaL to use?; 5) What is the effectiveness of the tools in IDeaL?; 6) How is ID Library used?; 7) What is the projected value and market for IDeaL? Evaluation instrumentation included logs, questionnaires, anecdotal record forms and telephone interviews.

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CAN COMPUTER-BASED TRAINING BE FUN? ARCO THINKS SO

Connie Haskell, Digital Equipment Corporation

ARCO refinery needed to train maintenance workers, engineers, and contractors to view, print, and markup on-line "blueprints". Digital Equipment Corporation created a unique CBI software emulation that motivates and holds your attention! Special features of the software include a playful storyline with cast of characters, audio instruction, MS-Windows with mouse interface, highly interactive game-like exercises, color graphics, and a unique feedback style.

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BUILDING A CONSORTIUM TO PRODUCE A COMPUTER-BASED LEARNING MODULE: CONCEPTS VERSUS EXPERIENCE

Brian E. Heckman, COMET

The University Corporation for Atmospheric Research (UCAR) formed COMET to serve as a bridge between operations, research, and education in the field of the atmospheric science discipline. The Distance Learning Program, one of three COMET programs, was formed to provide on site training and education for the nation's operational forecasters and selected university students. One task for the consortium is to produce computer-based learning(CBL) modules. Rather than create a large COMET core staff for this function, it was decided to rely on a series of cooperative and contractual agreements between universities, government laboratories, and commercial companies to produce the modules. Instructional designers and student interns (in addition to one core staff designer) are employed under an agreement between the University of Colorado at Denver and COMET; subject matter experts come from the sponsoring agencies, universities, or government research facilities. Production facilities are provided by the United States Air Force Academy through a quid pro quo with the National Weather Service (one member of the consortium) while programming is provided by a commercial contract with Poseidon Systems, Inc. of Boulder.

We have found from experience in developing the first two CBI modules distinct advantages and disadvantages of the initial concept. This presentation will discuss areas where changes are needed and the parts of the process that have been highly successful.

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ISD & SDLC: SIMILAR TUNES, DIFFERENT LYRICS

Michael J. Hillelsohn, McDonnell Douglas Space Systems

For those involved in developing courseware in a software systems development environment there are many issues related to both training development process and the timeliness of training products. The stages of the Systems Development Life Cycle (SDLC) model, used in software development, are similar to Instructional Systems Development (ISD) phases. SDLCs tend to be versions of DoD STD 2167A, which are customized for the program under development. When instructional materials have to be developed as part of the final system, it is important that the instructional designers be sure that instructional development concerns are accommodated by the SDLC which is adopted. Typically, the training deliverables which are defined in the SDLC are due during SDLC stages which do not coincide with appropriate times during instructional systems development. Modifying the training processes and deliverables area of the SDLC can produce training which better meets user requirements, because the training products are developed at the most efficient time in the development cycle of the software system. CBT can be thought of as a software application which should be developed, according to both ISD and SDLC methods. SDLC methodologies such as reviews, walkthroughs, inspections and systematic testing are entirely compatible with ISD methodologies and phases.

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"THREATBUSTERS" COMPUTER-BASED INSTRUCTIONAL GAME

John W. Keller and John A. deVries, Los Alamos National Laboratory

Using principles found in such computer games as "Where in the World is Carmen San Diego?" and "Duck Hunt," the Cognitive Systems Engineering Group of the Los Alamos National Laboratory developed "Threatbusters," a tool for teaching concepts in computer security. The game uses simulated interviews (dialogue) to present information that the student must then use to successfully complete the game.

A combination of text, graphics, and audio was used to provide a multilevel interface. This level of multimedia is handled by the use of Modula-2 based projector scripts. A database of knowledge on which the game is founded was developed in HyperCard. It was then electronically transferred to the PC and accessed as an integral part of the game. The shell of the game is independent of the content of the database; thus, the game can be used with other appropriate databases. This project also represents a unique development environment. Many people like HyperCard for fast prototyping but not for delivery. We used it to flesh-out ideas from brainstorming sessions. Once the basic structure of the game had been worked out, the PC-based delivery version was more easily realized. User testing was instrumental throughout the development process. Cross sections of the user population were asked to play the game at several stages during the development period. Their feedback was then used in subsequent versions. These techniques provided a unique and efficient way to develop computer-based trainers.

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CONDUCTING AND USING A TASK ANALYSIS TO FOCUS COMPUTER-BASED TRAINING MATERIALS

Frederick G. Knirk, University of Southern California; and
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Task analysis helps the CBT planner by identifying the tasks that must be performed by the trainee. The task listing/hierarchy provides the structure for CBT lessons and specifies the type of test items. In this session, we will: 1) review developing procedures for using a computer database to manipulate task statements; 2) discuss how to perform a task analysis for CBT course materials using a graphical interface; and 3) how to effectively use a task analysis in the design of those materials.

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JUST IN TIME TRAINING

Judith Morel, Marc Hopkins and Melissa Berkowitz, Tandem Computers

This presentation will address a technology-based training delivery program developed by the Software Education group at Tandem Computers, Inc. Tandem's Learning Center Program provides customer and employee training when it is needed, where it is needed, and on the subjects needed. The presentation will describe the Learning Center program, and demonstrate one of the CBT courses developed specifically for the Learning Center environment.

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INFORMATION REQUIREMENTS FOR LEARNER-CONTROLLED CAI

James R. Okey and Marshall G. Jones, The University of Georgia

Computer courseware is available that provides learners with numerous choices about sequence of content, amount and time of practice, kind of feedback received, or when to exit instruction and be tested. Increased control by learners over such decisions is thought to aid motivation and possibly be important in how knowledge is constructed and organized.

Despite the promise of learner-controlled instruction, some computer environments (e.g., hypertext materials) have the potential to lose learners in a morass of details, layers, and decisions. What kind of information do learners need if they are to make sensible and effective control decisions during CAI lessons?

The purpose of this presentation is to consider different kinds of actions learners may make during computer lessons (e.g., navigation, problem selection, content choice, or type of feedback to receive) and examine the kind of information learners need in order to exercise control in an intelligent way. Techniques will be described that are useful in providing information so that learners can exercise effective control of decisions during CAI -- these include content maps for navigation and course structure, graphs to depict achievement of outcomes, clocks to portray time spent, and text to convey the degree of mastery. Hypermedia programs will be used to illustrate how this information can be communicated to learners to promote intelligent and effective learner control in CAI.

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WRITING CBT FOR PROFIT - THE PRACTITIONERS' METHOD

Jeff Oliver, Castle Learning Systems Ltd

The conventional ISD model for courseware is fine in theory, but has shortcomings when writing CBT for commercial clients. Few CBT projects allow authors to take a 'top down' approach and traditional design scripts are unsatisfactory for describing modern CBT. Implementation issues need to be addressed early and time and budgets may force short cuts. To ensure customer satisfaction, the courseware needs to be accepted by all those involved.

"The Practitioners' Method" assumes that the client has identified the topic for training and that CBT is required. The stages of the process involve:

- Minimizing the less productive parts, such as finely defined objectives.
- Extracting subject matter and producing narratives, not detailed design scripts.
- Creating a prototype of the courseware for review and agreement.
- Producing intermediate versions of the courseware for testing and review.
- Systematic acceptance testing.

The method assumes that the design is rarely perfect first time and that change will be accommodated. Once the courseware is under development, changes are made in software rather than on paper - the only true documentation is the course itself. This presentation discusses the each stage in detail, drawing upon a number of past projects, with ideas for short cuts and maintaining customer approval.

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COMPUTERIZED CERTIFICATION EXAMS FOR REACTOR OPERATORS AT THE ADVANCED TEST REACTOR

L. W. Peterson and Lee. Ann R. Summers, EG&G Idaho Inc.

The training department for the Department of Energy (DOE) owned Advanced Test Reactor (ATR) is responsible for the certification of ATR reactor operators. The operators initial training program consists of two years of classroom and hands-on instruction culminating with comprehensive cognitive and operational exams. Once certified, reactor operators are tested annually to ensure knowledge and skills are maintained. In 1988, instructors at the ATR facility custom developed and hand graded over 130 written exams that met specific procedural and content guidelines. These former tests consisted almost entirely of essay type questions which have the advantage of evaluating higher level thinking, but the disadvantage of being inconsistently graded. With the expense of developing, grading, and completing a certification exam (about 10 hours per exam), a more cost effective and consistent method needed to be developed. After extensive research, the software package EXAMINER (Media Computer Enterprise) was modified, purchased, and installed on IBM PCs. The development of a data base structure, a system for creating valid, reliable question items, and a testing prescription strategy was completed prior to entering information into the software. In June of 1989, ATR administered it's fully computerized comprehensive certification exam for reactor operators with good success. Why the change was made, how testing requirements were met, the software features most appreciated by instructors and students along with other operator comments will be discussed during this presentation.

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A REVIEW OF COOPERATIVE, COMPETITIVE, AND INDIVIDUALISTIC GOAL STRUCTURES AS APPLIED TO COMPUTER-ASSISTED INSTRUCTION

Gary C. Powell, University of Georgia

The academic goals of individuals may interrelate in three ways: cooperative, competitive, and individualistic. The respective correlations are positive, negative, and no interdependence. Based upon the mode of interdependence in which interaction takes place, differing interaction patterns, motivational systems, achievement levels, and expectations for future achievement, will occur. Based on a literature search, findings and recommendations for CAI developers will be made.

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DEVELOPMENT OF INTEGRATED TRAINING SYSTEMS

Michael Reakes, Hughes Training Systems

This presentation examines the development of an *Integrated Training System*, defined as a well-designed system of courseware, training devices, training personnel and support systems, fully integrated to deliver *guaranteed*, qualified professionals, in the most cost-efficient manner. The role of a computerized management information system, termed *Training Management System* (TMS), as a tool in the management process is examined.

Development of an integrated training system starts with a careful analysis of the job to be trained. Application of the techniques of Instructional Systems Design (ISD) and Systems Engineering identify the job task, subordinate skills and knowledge, entry behaviors and characteristics, and determine performance objectives, criterion-reference test-items, and formulate an appropriate instructional strategy. This process leads to the development of specifications for the training system, including requirements for the training media. Typical training media for a large training system can include lectures and seminars, a computer-based training system, part-task training devices, high-fidelity training devices, and the use of the actual equipment - for example, the aircraft for flight training. Each lesson should make the best use of each training device to progressively increase the skill and proficiency level of each trainee to the required and guaranteed level.

Management of the trainee, instructors, curriculum and training media in a large Integrated Training System, is facilitated using an automated TMS. It maintains records of training conducted, tracks the progress of individual trainees, and progressively confirms that they attain the knowledge, skills and task performance required to meet the guaranteed performance levels. The TMS identifies any deficiencies of individual students, and recommend corrective action, such as supplementary training. The TMS allows the daily and hourly availability of trainees, instructors and training media to be specified, prioritizes training requirements, and performs optimal scheduling of training resources. The TMS allows quick rescheduling for the inevitable short-notice changes due to student or instructor illness, training equipment failure, and adverse weather in the case of flight training.

The TMS also performs analyses used in the operational evaluation of the integrated training system. The TMS collects and analyzes student performance data, student throughput and scheduling data, establishes meaningful trends, and generates reports, so that the overall training system can be improved.

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EVALUATION OF CBT IN ACCOUNTING

Thomas H. Rowley, Georgia State University

This paper describes a PC-based tutor that explains the accounting procedures used to prepare a complex financial statement. Reported are the results of a controlled experiment to evaluate student knowledge and retention using pretests, posttests, and midterm exam scores. Perceived usefulness reported by students is blocked by MBTI type. Also discussed are some CBT/ES opportunities for instructional design research in accounting.

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CBT DOWNUNDER: A REPORT ON THE 1990 AUSTRALIAN CBT CONFERENCE

Rod Sims, University of Technology, Sydney

This presentation will identify the major findings, issues and directions from each of the themes addressed during the CBT/90 conference, with the aim of providing a detailed perspective on the techniques used by Australian practitioners for effective CBT design, development and implementation. The conference featured keynote presentations on Future Directions in CBT and the benefits of introducing Embedded CBT systems, both of which emphasized the changing nature of CBT implementation concepts. The first invited paper focused on aspects of Metaphor-linked Authoring, and the increasing demand for user-oriented interaction; this was complemented by the complex demands of assessing and installing CBT hardware and courseware into the training system of an international airline. The major presentations were supported by presented papers which covered a range of issues including CBT Case Studies, Research, Computer-Managed Learning, Design & Development and CBT Applications. Of special interest and value were the outputs from the panel sessions, which have been documented in a small publication titled "CBT Issues". These sessions focused on simulation, authoring, accreditation, instructional design and user interface/screen design. Overall, the conference provided the framework for developing Australia's CBT industry through the implementation of innovative design techniques and alternative implementation strategies.

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SELECTING AN AUTHORING SYSTEM: TRADEOFFS, COMPROMISES, AND CONSEQUENCES

Linda S. Stanley and James R. Okey, University of Georgia

Dozens of CAI authoring systems with different features and capabilities are available for course development. Selecting an appropriate authoring system depends on factors such as the instruction itself, the skills and abilities of persons doing the authoring, and the environment in which the instruction will be used. Some authoring systems tradeoff power with flexibility. Some require programming ability and others are menu-driven. Some are suited to one kind of instruction, but not another. And some require lengthy training while others can be used after modest study.

In this paper, two factors to consider in selecting an authoring system will be examined. Two well-known, powerful, but highly dissimilar authoring systems (Authorware and HyperCard) will be contrasted. The same instruction developed with each system will be used to demonstrate their capability. An analysis will then be made of the two authoring systems in terms of development time used, type of authoring and programming skills required, compatibility with hardware, data-keeping capability, and ability of the systems to implement instruction in the intended manner.

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INTEGRATING RELATIONAL DATA BASE PRINCIPLES INTO CBT AUTHORING ENVIRONMENTS

Janet A. Wise, R. Ken Brownlow, and Angela G. Coburn, American Airlines

This presentation reports the results of our investigation into a new CBT authoring environment that includes modular integration of: computer software applications, Instructional Design tools, and a relational database.

Tools for developing Computer-based Training (CBT) have evolved from programming language to authoring systems. With the availability of new hardware and software technology, we are able to step beyond authoring systems into authoring environments.

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USING AUTODESK ANIMATOR™ IN COMPUTER-BASED TRAINING MATERIAL

Julian Wakeley, Abbey National plc

Abbey National, one of the United Kingdom's largest personal financial organizations, is an established user of Computer Based Training (CBT). It has access to over 1,500 terminals for training purposes and the subjects covered vary from procedural information to system simulations.

One large programme developed in 1990 was a complete training programme for the 1,000 Automated Teller Machines (ATM) installed throughout Abbey National. Due to the security implications, and the high cost of off-site training with real machines it had not been possible to show trainees the inner workings and maintenance procedures of the ATM until they needed to operate the machine in a 'live' environment (money loaded in ATM, on-line to mainframe, customers in building etc..).

The introduction of the current generation of animation tools has given designers the ability to integrate short video animation clips into standard CBT programmes.

This presentation details the process Abbey National undertook in developing short video sequences which could be used in CBT programmes. It will cover :

- Autodesk Animator™ overview
- Additional hardware requirements
- Design considerations
- Issues regarding integration into CBT material

This particular suite of programmes is under continual development and so the latest evaluation information will be made available as part of the presentation.

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RAPID PROTOTYPING METHODOLOGIES FOR COMPUTER BASED INSTRUCTION: TWO EXAMPLES

Sherwood Wang, University of Colorado; Dana Wunderlich, McAir Corp.; and D. Owens, and UCAR-COMET

Introduction

Rapid prototyping is an emerging and important element in instructional systems design today. There are several ways which rapid prototypes can be used in an instructional design setting. This presentation will highlight two distinct applications of rapid prototyping emphasizing the diversity of functions that prototypes can fulfill.

The McAir Story Board Developer

Several computer based training programs currently being designed at McAir use a word processing program for the creation and revision of storyboard documents. This approach has brought to light many practical problems which impact both quality and productivity. In response to these problems, a structured storyboard development tool was created at McAir using a rapid prototyping approach. Input was elicited from the storyboard authors in the initial planning stages and throughout the development of the tool through informal meetings and "wish lists". Many of these features were then implemented in a Macintosh environment using Hypercard. The tool was put to use as soon as an initial version was created and updates (31 to date) were circulated as the original program was amended. There was a constant flow of input from the courseware authors about the needed improvements to the tool which directed the type of enhancements which were implemented.

WorkStation Prototyping at UCAR-COMET

UCAR-COMET (University Corporation for Atmospheric Research-Cooperative Program for operational Meteorology Education and Training), based in Boulder Colorado, is currently engaged in producing a set of computer based, interactive video modules on interpreting weather radar images and forecast methodology for several government agencies. There were several circumstances unique to this project which led choosing a rapid prototyping approach. First, the goal of creating a realistic working environment required a complex and time consuming programming effort. This created problems for designers because they could not fully envision the final product. Rapid prototyping allowed the design team to utilize an iterative process, refining their conceptions of the user interface and functionality without being burdened with the details involved with the final programming effort. The prototypes were also used to demonstrate the functionality of the final product to the sponsoring organizations and to facilitate communication between the designers and the programming team. Formative evaluation with typical users was also a problem for the design team because of the time lag between the lesson designs and the final delivery system. The rapid prototype allowed typical learners to provide feedback on the user interface before a permanent version was created by the programming team. This prototype was implemented in a Macintosh environment using Supercard.

This presentation will detail some of the design considerations which went into both prototypes and highlight the functional similarities and differences in the design and implementation of the prototypes as well as demonstrating the two prototypes.

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INTEGRATING RELATIONAL DATABASE PRINCIPLES INTO CBT AUTHORING ENVIRONMENTS

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This presentation reports the results of our investigation into a new CBT authoring environment that includes modular integration of: computer software applications, Instructional Design tools, and a relational database. Tools for developing computer-based training have evolved from programming languages to authoring systems. With the availability of new hardware and software technology, we are able to step beyond authoring systems into authoring environments.

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HOW TO TALK TO A SUBJECT MATTER EXPERT

Larry E. Wood and John M. Ford, Brigham Young University

Using adaptations of methods from several social science disciplines as well as instructional science, we have developed a method for interviewing subject-matter experts when gathering information for instructional and training systems. Our approach consists of four components with guidelines for questions suited to each component. First, the descriptive elicitation stage is intended to reveal the important entities and concepts in the domain as reflected in the terms and specialized language used by the expert and provide the general structure of domain problem solving. A second stage, structured expansion, is designed to probe the attributes of domain concepts and entities, the relationships between the domain concepts, and the organization of the expert's knowledge, using the terminology uncovered in the previous stage. The scripting stage relies on the declarative knowledge found through the two previous stages to discover detailed procedural knowledge (at both macro and micro levels) involved in solving domain problems. A final component, validation, is important throughout the process of knowledge gathering to ensure that the knowledge being elicited is correct and adequate for its intended purpose.

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Special Interest Group for Elementary, Secondary, and Junior College Education (SIGELSECJC)

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AN ENVIRONMENT TO LEARN ARGUMENTATION

André Boder, Project Start Up

Hypertexts can be a powerful tool in CBI. So far, most learning environments created with this tool have been built in the spirit of electronic books. Some didactic methodology should be provided along with the database. Very often it is not the case. The reason is probably that these environments include clear navigation devices.

The environment presented here is an example that, in addition to their strength as a flexible and very interactive database, hypertext tools can assist in the thought process brought to bear by the student in a situation of knowledge acquisition.

The environment is a simulation of the defence of a law case. In the process of finding an appropriate defence plan, strategies, hypothesis, comparisons, analogies, classifications and other conceptual analysis are developed by the students. The environment makes full use of resources provided within CBI to assist in these thought processes. It also shows how control can adequately be passed from and to the machine whenever feedback is needed. Also strong emphasis is put on making links between different domains of knowledge involved (logic, law, third-world issues, human relations). The environment is designed in such a way that both top-down and bottom-up reasoning are induced.

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LOGO INSTRUCTION AND STUDENT'S ORDERED TREES OF PROGRAMMING CONCEPTS

Gregg Brownell, Bowling Green State University; and Dieter Zirkler, Mead Corporation

This study examined the development of mental models of Logo programming concepts in 17 5th through 7th grade students. Using the ordered tree technique, measurements of student's mental models were obtained in the first, third, and fifth weeks of a five week computer camp. Student's understanding of basic Logo commands was measured at the same intervals. Student's mental models of Logo keywords developed significantly ($\underline{p}<.001$) in organization during the camp. Development in the organization of student's mental models was significantly ($\underline{p}<.05$) related to student's understanding of Logo keywords. This suggests that small amounts of instruction in programming can have an impact on student cognition. Changes in student's representation of programming concepts may be the first step in developing programming and general reasoning skills. If, however, students spend a long time developing accurate models of a programming language, they may have limited time to develop higher-order reasoning skills. Educational programming environments that minimize the differences between mental models of novice student programmers and the conceptual models underlying educational programming environments would seem to be a desirable aim for software developers.

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CAI DESIGN FOR METACOGNITION

Bernard J. Dodge, San Diego State University

Recent research has supported the importance of teaching learners to become aware of their own cognitive processes. The design of a project to teach metacomprehension with a simulation game for at risk high school students will be described.

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A MEDIA CENTER FOR THE 21ST CENTURY

Vicki Durbin and Donna Schell, Yavapai School

The onset of the Information Age brings unique challenges to schools as we grapple to keep up with the vast amount of information available. Yavapai School has met this challenge with the opening of a new, state-of-the-art, technological media center. It is a media center geared to allow our school community access to information and to apply it in meaningful and knowledgeable ways. An array of services incorporating computers in nearly every facet of operation and most learning situations make Yavapai a truly futuristic school.

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COMPUTERS, CRITICAL THINKING, AND FRESHMAN COMPOSITION

Rex Easley and Gary Vaughn, University of Cincinnati

The use of computers in the freshman composition (writing) classroom opens up a number of possibilities beyond word-processing and text revision activities. Some software, such as Writer's Helper by William Wresch, offers writing assistance in the areas of generating and organizing ideas as well as analyzing texts for readability level and other "mechanical" aspects. Writer's Helper can also be used as the basis for assignments which promote critical thinking skills, creativity in writing, and development of an authorial voice appropriate to a number of writing situations.

In this presentation we will discuss the use of the computer and the Writer's Helper software, in conjunction with word processing capabilities in several writing assignment projects which promote critical thinking skills by requiring students to generate ideas, make choices, and follow the implications of those choices in the planning and writing of an extended essay. The assignments are based on a creative writing approach to reading and writing about short stories. They rely on reading and predicting, personal response to what is being read, short writing assignments that ask for creative writing responses to situations, and a collaborative project that lets students resolve writers' dilemmas. All of the reading and writing assignments use Writer's Helper in a number of ways to facilitate the students' work on their writing.

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THE COMPUTERIZED WRITING CLASSROOM AND "HIGH RISK" COLLEGE LEARNERS

Rex Easley and Gary Vaughn, University of Cincinnati

Junior colleges across the country are confronting the challenge of how to attract and retain adult returning students. As we move into the 1990's, access to education for non-traditional students can be enhanced by the computerized classroom.

In the two-year, open admissions University College of the University of Cincinnati, writing instructors are in the fifth year of a continuing study of the effects of word processing and critical thinking software on the composing processes and attitudes toward writing of developmental writers. Most students in the basic writing class (English for Effective Communication) are recent high school graduates; however, many are admitted through the Pre-Technical Training Program, a course of study funded by the Job Training Partnership Act and designed to attract older, "high risk" students to the college environment. The "average" Pre-Tech student is highly motivated, but her ambitious goals are often hindered by a lack of comfort with her academic abilities. The research study at UC divides the basic writing classes into sections that use a simple word processor, sections that combine the word processor with thinking- aid software, and classes tnat do not use computers at all. Our non-traditional Pre-Tech students in the computer environment perform better on a holistically graded final exam than do their traditional counterparts. We believe the adult learners perform better when working with computers because this type of learning environment assists the adult learning style outlined by Malcolm Knowles, Stephen Brookfield, and Paul Westmeyer. The computer allows such students a "co-directed" learning environment where they are free to take risks and experiment with language. In addition to improving their writing, they appear to improve their attitude toward writing, as revealed by an end-of-quarter questionnaire. Our research suggests that computers and carefully chosen software can help bridge the gap between "high risk" adult learners and a college education.

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COMPUTER-ASSISTED INSTRUCTION ON THE MAC II

Mary M. Finnen, Steven M. Lawton, Bryce Bate, Kathleen Davey, William Jensen, and Russell Skavaril, The Ohio State University

The Mac II computer and the authoring software AuthorWare Professional has provided an effective platform for designing general biology instructional materials. The program, Encounters with Biology, engages the student in a question-and-answer session that assists the student in discovering why biological terms and concepts are important. The program makes effective use of hi-resolution color images, audio, and discovery-learning techniques.

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HISPANIC MATH PROJECT: A MULTIMEDIA LEARNING STATION

Wayne Hartschuh and Rocio Sanchez, Arizona State University

The Arizona State University Hispanic Math Project (HMP), sponsored by the National Science Foundation, is developing an intelligent, computer-based interactive video learning station capable of adaptively diagnosing and individually tutoring sixth-grade migrant Hispanic students. The learning station is coordinated by an expert system which individualizes instruction with regard to content, language and delivery medium, provides empirical data about the interaction of these factors and evaluates them in order to better integrate these domains during the system's interaction with the student.

The major goal of the Hispanic Math Project is to promote the achievement of migrant Hispanic elementary students in mathematics - focusing specifically on the mathematics of measurement. A second major goal is to explore the effectiveness of individualized computer technology to complement classroom teachers in addressing the critical elements in migrant Hispanic education.

The presentation will focus on the development of the HMP Learning Station and its implementation in the schools. The research data from the project will provide educators with information that can be used to distinguish between math difficulties and language barriers so that future instruction may take into account the interaction of these variables.

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FACTORS INFLUENCING THE ADOPTION AND IMPLEMENTATION OF AN INNOVATION

Frances Hensley, The University of Georgia

Schools have been slow to adopt and implement computer-based educational innovations, including computer assisted instruction. Whereas, generally, the most attention in the development and implementation of an innovation is paid to the technical aspects of the innovation, such as its goals, objectives, materials, and means, and while this dimension is critical, it alone can not explain the success or failure of an innovation in a school setting. In an attempt to better understand the factors which influence the adoption and implementation of an innovation into a school setting, a multidimensional model is offered.

Based on a review of the literature on school change, this model includes four dimensions: the technological, political, cultural, and psychological. The use of this model allows for the examination and consideration of various dimensions of an educational innovation and how these dimensions impact and interact with one another during the innovation's development, implementation, and evaluation. This presentation will discuss each of these dimensions and advocate for the need to examine educational innovations through the use of a multidimensional model which allows the consideration of the richness and complexity of both the innovation and the environment in which it exists.

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PERSONAL AND ACADEMIC APPLICATIONS OF HYPERCARD: A HIGH SCHOOL COURSE

Annette Lamb, University of Toledo

HyperCard has become a popular tool for educators. Because of its ease-of-use, many educators are recommending it as an excellent tool for students. This presentation describes the use of this tool by high school students within a high school computer applications course. A course outline and sample class activities are discussed. Class activities include information presentation and exploration, interactive stories and reports, note taking systems, and surveys. In addition, the use of emerging technologies such as scanning and CD-ROM technologies are discussed within the context of practical, personal and academic student projects.

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MANAGING THE COMPUTER-BASED CLASSROOM

Frederick Knirk and Mary Pinola; University of Southern California

Teachers at all levels of instruction are challenged to manage the computer-based classroom. Management is critical as students have increased access to computers in and out of the classroom. This presentation will describe strategies for: 1) monitoring the application of computers to instructional tasks and for conducting on-going evaluation of student response and teaching systems; 2) promoting active learning; 3) selecting appropriate media and instructional methods; and 4) responding to accountability requirements.

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COMPUTERS IN EDUCATION: A GRADUATE PROGRAM DESIGN

Lynne Levy and Louis Molinari, Glassboro State College

The unique post-baccalaureate program, *Computers in Education*, is a certificate program at Glassboro State College, Glassboro, New Jersey. A major goal in this design is to encourage seasoned educators to incorporate the computer in their classroom so that articulation between technology and regular classroom activity can become a working reality.

This 18-semester hour graduate program provides participants with a comprehensive knowledge of computer use in the educational setting. The program helps the participants to become competent in computer utilization for instructional, administrative, as well as personal use. The program can be completed as a stand-alone certificate program, or it can be incorporated into a master's degree emphasis area; thus affording teachers the opportunity to continue their professional development while acquiring a new area of expertise.

Elementary and secondary teachers are serviced by this program, along with provisions for supervisors and school administrators. Instruction is delivered in both on-campus and off-campus settings. Instruction utilizes both the IBM and/or Apple systems depending on district needs and specific course requirements.

This program is the primary training ground in computer-related instruction for teachers in Southern New Jersey. Modifications are made in the design to accommodate district needs and to provide teachers with new developments in classroom computer applications.

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WHICH PARENTS SEND THEIR YOUNG ONES TO COMPUTER CLASSES AND WHY

Charlotte Scherer, Bowling Green State University

Parents who enrolled their four and five year old children in a computer class on the BGSU campus completed a questionnaire designed to gather demographic data and information about their reasons for putting their children in the class. Their general attitudes about the importance of computer competence were also surveyed. Since this is the only computer class of several children's offerings which has consistently been filled to overflowing, the investigator was curious about its extreme popularity. Did parents believe that an early start was necessary for later success in school? Did parents believe that young children could use computers to learn numeric and alphabetic skills? Did they think that computers were fun for preschoolers? What was the parents' educational level? Such was the nature of the questions asked in this survey.

Results indicated these highly educated parents in a college community thought their children would have fun and enjoy learning to use a computer, but follow-up phone calls to 14 parents indicated they also felt it was important, with computers so widely used, that their child know how to use computer as soon as possible. They also felt that computers could help their child learn basic skills.

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THE TALIESIN PROJECT: INTEGRATED CURRICULUM USING HYPERMEDIA

Eric E. Smith, University of Northern Colorado; and John Redman, Hewlett-Packard Company

The first year of the Taliesin Project, its theoretical foundations, the development of Pilot materials, and the approach to meeting the need of improving the mathematics, science, and technology skills and knowledge of students in K-12 education in the United States are discussed.

At the root of the project are the beliefs that teachers play pivotal roles in the education of children and that children can and will learn about mathematics, science, and technology if their interest can be captured, Relevance to them is shown, and their confidence with the content in increased.

To meet these concerns, it is necessary to provide teachers with content and materials that can be made interesting and relevant. This project uses richly textured initiating media (e.g. movies, books, athletic events) that illustrate technological or natural systems from which scientific principles and mathematical concepts are derived. By using hypermedia, access to multiple paths through the material are available to met both student and teacher needs and preferences. While the system supports almost any instructional model, the materials under development follow Elaboration Theory and Cooperative Learning paradigms.

The Taliesin Project is a cooperative project of the University of Northern Colorado, Hewlett-Packard Company, and several school districts in the state of Colorado.

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FRENCH AND GERMAN DICTION: DESIGNING AN ADAPTABLE HYPERCARD STACK

James T. Talley and Donna E. Williams, The Ohio State University

Since creating courseware consumes a considerable amount of time, it is essential to conserve development time wherever possible. One means of time savings is to survey existing courseware before allocating resources for development. Another is to adapt existing courseware to fit the needs of multiple users. Our presentation will focus on the development of a HyperCard stack that has been adapted for use in two courses.

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INSTRUCTIONAL TRANSFORMATION THROUGH INSTRUCTIONAL TECHNOLOGY: A MODEL FOR CHANGE

Robert Wambaugh, Pennsylvania State University

The National Task Force on Instructional Technology (1986) called for the educational systems of the United States to undergo immediate reformation and work toward eventual transformation in order to take advantage of the potential of new instructional technologies. The Penn State Regional Computer Resource Center is proposing a five step model for introducing technology into the schools suggesting a hierarchy of steps that must be worked through if the tools of technology are to be appropriately applied to education.

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MOVING STAND-ALONE COURSEWARE INTO A MANAGED SYSTEM

Paul Wieser and Eileen Wilkie, MECC

MECC Management Master (MMM) is a courseware management system that delivers lessons based on MECC software, records performance data, and reports that data. It was developed to assist teachers who want to integrate MECC reading and math software into their curricula, yet may not have the time to correlate the software to their objectives or track student performance in order to insure that students receive appropriate instruction.

The instructional software managed by MMM was originally developed to stand alone, delivering instruction addressing discreet instructional objectives. Moving this software into a managed system that is curriculum-based poses two major challenges. First, the software must be analyzed for instructional objectives and a means of assessing student performance on the objectives must be developed. In some cases, the stand-alone courseware needs few modifications in order to fit into the system, but in other cases significant changes must be designed and implemented. The second major challenge comes in designing the correlation process: analyzing textbooks, establishing rules for when correlations will be made between textbook lessons and MECC software and deciding how program parameters will be set for given lessons or groups of lessons.

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Selected Abstracts for the

Special Interest Group for Emerging Technologies (SIGET)

THE EFFECTS OF ACCESS TO SIMULTANEOUS INTEGRATED INFORMATION SYSTEMS ON LEARNING

Ruth Curtis and Barbara L. Grabowski, Syracuse University

With the rapid development of interactive learning systems, vast amounts of information can be presented simultaneously through the integration of text, graphics, audio, and video formats. Research that defines the characteristics and relationships of and differences between information-based systems and instructional technology systems will lead to understanding their capabilities and developing appropriate applications which facilitate learning.

Using an intensive design approach, this exploratory study investigated ways in which the users' prior knowledge, motivation, and cognitive processing influenced the way in which they accessed and processed information through interactive systems. Six entering freshmen (two males and four females) were observed as they explored the ABC's *Election '88* Interactive Videodisc. First, Witkin's Group Embedded Figures Test was administered to determine their level of field dependence/independence. Prior to and after exploring the Election '88 disc, they were asked to draw a pattern note to assess their prior and post organization of knowledge, and were administered an assessment using Keller's (1986) ARCS categories to determine their level of motivation in the '88 elections and the interactive video technology.

In an exploratory way, both qualitative and quantitative data were used to examine the results. Qualitative methods were used to analyze the phenomenon of the complex interrelationships and dynamic nature of cognitive processes involved in interactive information retrieval. This method enabled us to examine natural interactions operating among variables in real learning situations (Vacca and Vacca, 1980). Quantitative methods were used to determine the effects of various navigational patterns on achievement and motivation. Results will be presented which interrelate the qualitative and quantitative findings.

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SNOWMAN: A SYSTEM FOR KNOWLEDGE MANAGEMENT

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We have developed a prototype "knowledge editor" for documenting and managing information gathered from experts during development of instructional and training systems. It is designed around the distinction between declarative knowledge (domain concepts and objects and their relationships) and procedural knowledge (the use of declarative knowledge in solving domain problems). For declarative knowledge, the tool allows the user to enter concepts and their relationships, display individual concepts and their relationships with others, and to graphically display relationships among concepts in a semantic network. For representing procedural knowledge, the tool provides the capability for using structured outlines, the components of which can be easily inserted into a free-form text field. As an editor, the tool allows for revision and updating as additional information is gathered. Furthermore, it provides the capability to represent knowledge in a form intermediate between original sources and final product. This makes it possible to verify and validate it prior to a "production" stage. The prototype was developed on a Macintosh computer in SuperCard.

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ADDING A HYPERMEDIA INTERFACE AND HELP SYSTEM TO AN EXPERT SYSTEM ADVISOR

R. Scott Grabinger and David H. Jonassen, University of Colorado at Denver

A useful application of an expert system is as an intelligent job aid for facilitating the design and development of instruction employing the instructional systems design process. The IDD Advisor is an expert system for facilitating the design and development of instructional sequences. The IDD Advisor employs two major emerging technologies: (1) an expert system using a structured rule base; and (2) a hypertext front end and support system containing the user interface to the expert system and the conceptual knowledge for understanding. Specifically, the IDD Advisor provides consultation on the selection of an instructional tactic for a given instructional situation described by the user. However, advice is useful only if it can be applied correctly to the instructional situation. Therefore, an advisor needs to provide background conceptual information along with the rules that help the novice make decisions. The solution that we have adopted is to integrate a hypertext-based user interface and online help system to facilitate access to the information and provide the conceptual knowledge needed to understand the all of the terminology needed to make decisions as well as the results of the consultation. The IDD Advisor demonstrated at ADCIS is a combination of the the *Level5* expert system and a hypertext system produced in HyperCard.

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EMERGING TECHNOLOGIES AND LEARNING ENVIRONMENTS: FROM INSTRUCTION TO LEARNER CENTERED MODELS

Michael J. Hannafin and James Gall, Florida State University

During the past 20-30 years, interest in computer-based instruction (CBI) has grown dramatically. Enhanced power, increased availability of peripheral devices, and developments in hypermedia have created extraordinary potential for CBI design. Likewise, recent developments in expert systems, artificial intelligence, and knowledge engineering have yielded interesting perspectives on software design, with considerable long-term promise. At the same time, there have been significant, though largely unexploited, advances in cognitive psychology, situated cognition, and constructivism. Collectively, these advances offer the potential to redefine learner-computer interaction.

Yet, in many ways, our designs have failed to evolve accordingly. Most efforts based upon contemporary psychological and technological developments have emphasized new ways for the computer to organize instruction rather than new ways to empower students to learn. In effect, we invent new ways to do old things, but not new things. We work to optimize the capabilities of the technology by emphasizing externally centered adaptation, but often fail to break new ground in learner-centered designs.

How can the potential of emerging technologies, and related developments in cognitive psychology, be combined to yield fundamentally different learning experiences? One possibility lies in the growth of interest in learning environments. Learning environments are problem-centered, multi-dimensional systems designed to provide highly contextualized learning opportunities. The problems typically require resolution by the student of some inconsistency, problem, or crisis through guided exploration among related components. Components such as a knowledge base, pedagogue, linkways to related concepts, and so forth, are organized interactively to reflect concurrently the interdependence among related knowledge and skills. Students maneuver through the environment using readily accessed tools and system utilities which permit interaction at multiple levels (e.g., navigation, manipulation, hypothesis testing, etc). In this presentation, the rationale for, and attributes of, learning environments will be presented. In addition, working prototypes of learning environments will be demonstrated, and audience participation will be solicited.

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INTEGRATING HYPERMEDIA AND KNOWLEDGE-BASED SYSTEM TECHNOLOGIES FOR TRAINING AND INFORMATION DISSEMINATION

Francis A. Harvey, Lehigh University

The goal of the Combined Advanced Information Technology Systems (CAITS) Project at Lehigh University's Engineering Research Center for Advanced Technology for Large Structural Systems (ATLSS) is to utilize traditional database systems, hypermedia, and expert systems technology to develop intelligent hypermedia-based information systems. Systems developed will be used for the support of engineering research, for training on ATLSS systems, and for transfer and dissemination of the results of ATLSS projects.

Systems developed use a synergistic combination of powerful database management software (for information storage and retrieval), knowledge-based systems (to support user's formulation of search strategies, evaluation of search results, and utilization of the information provided by the information system), and hypermedia (to provide an intuitive, easy, and efficient user interface to the overall system). Specific development techniques currently in use or being planned include the use of knowledge engineering techniques developed for expert systems to optimize the use of subject matter experts in designing and developing hypermedia materials and the use of hypermedia to provide graphical navigation and browsing support for users of existing intelligent information systems. This paper will describe the systems under development and will discuss how the techniques and procedures developed can be applied to information/communications needs in other domains.

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NEW DIRECTIONS IN HUMAN FACTORS FOR INTERFACE DESIGN

Hueyching Janice Jih and William H. Wheeler, Jr., University of Georgia

Courseware designers are bombarded with promise of authoring tools, especially authoring systems as HyperCard, Linkway, Course of Action, or ProPi. Most of designers are lulled to believed that a wonderful authoring system sill guarantee them a high-quality program. Very little is mentioned about the interface design consideration which is an essential authoring skills needed to create good interactive courseware.

The interaction between a computer-based instructional system and its learners can be influenced by both the system itself and the engagement of the learners, such as reflecting, thoughtful, visceral, and changing, through learner-computer interfaces. In order to increase the learner's satisfaction and performance and to create high-quality interactive courseware, designers must take human factors in learner-courseware interaction into account with specific reference to perceptual, physiological, and psychological aspects. This presentation discusses the human factors consideration as a new direction for computer-based courseware design. Objectives of this presentation include: introduction to human factors issues in interaction; the importance of human factors for courseware designers; and design guidelines for Computer Assisted Instruction (CAI) or Computer-Based Training (CBT) programs. The design guidelines forms the architecture of this presentation.

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THE PHYSICS TUTOR: BUILDING AN INTELLIGENT TUTOR FROM HYPERTEXT AND EXPERT SYSTEMS

David H. Jonassen and Sherwood Wang, University of Colorado

This presentation describes the construction of an intelligent tutor from hypertext and expert systems. The expert model in this prototype is implicit in the hypertext structure and represented in expert system rule bases. The student model, a combination of declarative, structural and procedural knowledge, is constructed in expert system rule bases. The tutor will be built in expert systems also. This prototype is built in HyperCard and Level 5 on the Macintosh. It is designed to demonstrate intelligent functionality on a personal computer using existing software.

Introduction

Intelligent tutors are expensive to develop because of the knowledge engineering and programming requirements, and they are expensive to implement because of the computational requirements. This paper presents a prototype intelligent tutor constructed with hypertext and expert systems. The combination provides most, if not all, of the required functionality of an intelligent tutoring system.

Intelligent tutors provide a meaningful option to traditional CBI. They are a knowledge based form of intelligent computer based instruction, normally consisting of a model of the expert's knowledge, a student diagnosis module, an instructional environment, and a human-computer interface (frequently a natural language interface). The knowledge model is typically based upon a semantic network, consisting of objects, properties, or concepts which possess names, values, or tags for accessing the object. Of all of the intelligent tutoring systems (ITS) reviewed by Wenger (1987) and Polson and Richardson (1988), none run on personal computers, and all have required large development teams to produce tutors on limited topics. If ITS is to impact education, they must be developed for popular PCs using available software.

Objective

Our goal is to produce and demonstrate a prototype ITS program using an integrated system of hypertext and expert systems. We intend to use commercial software and Macintosh computers to demonstrate the feasibility of a generic ITS system.

Jonassen, Grabinger, and Wang (1990) demonstrated different applications of the integration of hypertext and expert systems. Among these, expert systems may function as diagnostic tools for accessing the hypertext. We demonstrated a preliminary prototype of an ITS. The only student modelling in our preliminary prototype was programmed in Hyper. Talk. We are continuing this work by developing student modelling rule bases to analyze learning styles and prior knowledge and to assess knowledge acquisition during instruction. We hope to tie the assessment knowledge base to the expert's knowledge base in order to prescribe the most productive learning paths. We demonstrated those learning paths in our presentation.

Our general hypothesis is that hypertext and expert systems provide most, if not all, of the functionality of an ITSA well designed hypertext interface can supplant most of the need for natural language. As an instructional environment, hypertext can explicitly model the expert's knowledge structure as well as providing sophisticated instructional transactions that elicit any type of information processing desired (Jonassen, 1989; Jonassen & Mandl, 1990). Expert system knowledge bases can model both the expert's and novice's knowledge structure and prescribe appropriate instructional sequences. We are implementing this model in the form of a Physics Tutor.

The Physics Tutor is a prototype instructional physics information base designed to familiarize students with the basic concepts in rectilinear Newtonian physics. It is written in HyperCard and utilizes node and link structure to organize information contained in the program. The program also utilizes an expert system shell to analyze student responses and to provide models of student understanding.

Interactivity is emphasized in the program at several levels. The system allows for browsing using a graphical overview, which shows the relationships between the concepts spatially. There are also two modes of structured browsing in the system. The user interface is structured so that the learner may both request information from the system or be quizzed on structural or procedural knowledge contained in the system (Carbonell, 1970).

The expert system shell, Level 5, functions transparently behind the HyperCard stack, to organize responses to users' questions regarding relatedness of concepts in the information base. It also navigates the student through a series of nodes to show the relationship between concepts. The expert system will also be used to create a model of the learner's understanding of the relationship between concepts and prescribe sequences of nodes to correct the student model if necessary.

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DESKTOP PRESENTATIONS: TIPS FOR USING HYPERCARD AS A PRESENTATION TOOL

Annette Lamb, University of Toledo

Educators at all levels are using *HyperCard* as a presentation tool. Unfortunately, many users are not following guidelines for the development of effective presentations. This presentation discusses the design and development of effective desktop presentations including selection of content, screen design and layout, typography, and use of graphics. It provides ideas for large group, linear presentations, and "kiosk-type" presentations. It also discusses the development of complex presentations that make use of *HyperCard*'s branching capabilities.

Easy methods for scripting presentations are highlighted, in addition to the use of presentation templates. Ideas for creating graphics and scanning images are also discussed. Finally, the use of emerging technologies such as compact discs and laser discs is discussed.

The presentation concludes with some general information regarding the delivery of desktop presentations including equipment and the use of supplemental handouts.

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INTEGRATED PERFORMANCE SUPPORT SYSTEMS

Kathleen Long, Jan Hermanns, and Clarence J. Ross, Anderson Consulting

There was a time when most training was conducted in the classroom and via one-on-one coaching. More recently, much of that training has migrated to self-study alternatives such as workbooks and computer-based training, employing a variety of supporting media.

Today there is tremendous emphasis on building a competitive workforce, particularly in the use of computer systems and applications. It is no longer pertinent to view training as an event, apart from the job. Rather, it must come in many forms as part of an Integrated Performance Support System (IPSS), which can be accessed in relevant bits and pieces during job performance. The goal is to provide exactly what the learner needs, as quickly and easily as possible, at the right level of depth, with minimal disruption to job performance.

This presentation focuses on what an IPSS is and how it can provide more efficient and effective training and support than more traditional methods. The various components of an IPSS will be illustrated and discussed: Job competency diagnosis and prescription; Multi-level helps; Job aids; On-line and paper-based reference; On-line and off-line training; Knowledge-based advisors; and Update bulletins.

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FORMAL INITIAL STEPS IN THE DEVELOPMENT OF EXPERT SYSTEM COURSEWARE

Brother Matthew Michelini, Manhattan College

Classroom teachers develop and use a wide variety of courseware materials to enhance learner understanding. Many of these courseware materials involve some form of learner self-evaluation through the use of multiple choice questions. With some modification to the program design these self-evaluation materials can offer the learner greater latitude in receiving more detailed information concerning both correct and incorrect responses.

Articles and presentations concerning interactive and expert system courseware have demonstrated the interactive aspects of the courseware while little focus has been given to the design and implementation steps necessary for making the courseware more interactive and Expert System in nature. The objective of this session is to:

1. demonstrate the interactive nature of courseware in presenting self-evaluation questions,
2. demonstrate how the learner has access to additional information concerning the answers to the self-evaluation questions,
3. illustrate how a BASIC language program can be altered to allow the programmer to incorporate more interactive and Expert System oriented programming into self-evaluation courseware.

The presentation will consist of a computer demonstration of the courseware both in the old and revised formats, a computer printout of program statements used in the production of the courseware, and an overhead transparency presentation of what modifications have been made to make the courseware more interactive and Expert System in nature.

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Selected Abstracts for the

Special Interest Group for Education of the Handicapped (SIGHAN)

NETWORKS FOR LEARNING IN GROUPS: RESULTS WITH HIGH-RISK HIGH SCHOOLERS

Steven L. Robinson, Wilder Research Center

Research in teaching reading competency skills to dropout prone high schoolers was conducted over a one-year period. A technology-based networked system was used to deliver instruction in groups of 15-23 students. This session will describe the technology system, development of material, research design and results.

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SPECIAL EDUCATION TECHNOLOGY RESOURCE CENTER: A REPORT ON THE USE OF CBI TO TRAIN SPECIAL EDUCATORS

Marshall G. Jones, Gary E. Ross, and John Langone, University of Georgia

This presentation will focus on the progress of the Special Education Technology Resource Center (SETRC) at the University of Georgia. A report will be given on the development of a new interdisciplinary component to the master's degree program that will train special education technologists. Computer-based instruction modules, developed primarily in HyperCard, to train special educators will be demonstrated. Many of these modules will be made available as part of the demonstration.

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Selected Abstracts for the

Special Interest Group for Health Education (SIGHEALTH)

EMULATED ORAL EXAMINATIONS: EXPERIENCES AND PROJECTIONS

Michael Anbar and Ada Anbar, State University of New York at Buffalo

The efficacy of computerized open-ended examinations in assessing knowledge and reasoning ability was compared with that of multiple choice questions answered by the same students in the same session, and with their performance in the same course assessed by short essay answers and term papers. The emulated oral examinations differentiated better than the levels of the students, and revealed substantially more about their mastery of the material.

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NUTRISMART: AN INTELLIGENT NUTRITION ANALYST AND ADVISOR FOR HEALTH CARE PROFESSIONALS

Wm. J. Fetter and Saroj M. Bahl, University of Texas, Health Science Center

Dietetic programs include clinical nutrition as an integral component of their curriculum. The dietetic student has to acquire a considerable amount of information then synthesize and apply the pertinent knowledge in the creation of an individualized nutritional care plan (SOAP note). This progression from theory to practice is, however, a difficult transition. Furthermore, rigid time constraints placed on students' learning makes this transition even more difficult and anxiety-provoking. Clinical case studies or patient simulations that are designed for computer delivery provide an excellent self-instructional, self-paced approach for presentation of nutritional care principles to a dietetic student.

A Neural Network mimics the way we learn and make decisions, hence can function as an "expert" in this setting. This program combines a Computer-Based Patient Simulation with a dynamic Neural Network knowledge base. The student interacts with the simulation to learn as well as practice with the concepts necessary and preliminary to the development of a nutritional care plan. After completion of the SOAP note, the student consults with the Neural Network Expert (INA) on the accuracy of the plan. Appropriate case studies in various content areas - cardiovascular disease, gastroenterology, diabetes, cancer and renal disease are included in the program.

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ANAEROBE DETECTIVE: AN INTELLIGENT SIMULATION ADVENTURE GAME

Wm. J. Fetter, Paul G. Engelkirk, Janet Engelkirk, University of Texas Health Science Center

Medical Technology Education programs typically include medical microbiology as an integral component of their curriculum. Many of these programs, however, neglect to teach, or fail to emphasize the importance of anaerobic bacteriology. Therefore, a large number of medical technologists lack the knowledge and experience needed to perform presumptive identification of anaerobic isolates.

The Anaerobe Detective Adventure Game combines a Computer- Based Adventure Game format with an artificial intelligence knowledge base. The student interacts with the game by trying to solve a mystery using a minimum number of clues. The game begins at the scene of the crime. The victim is suffering from a severe infection. The suspect is one of 12 anaerobic bacteria, but which one? The learner, using a logical, step-wise approach must collect the significant clues, piece them together and solve the mystery. The game offers both an opportunity for the student to learn how to perform presumptive identification of anaerobic bacteria as well as sharpen their logical reasoning skills.

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PEDIATRIC RESIDENT SATISFACTION WITH NATURAL LANGUAGE INTERFACE IN A COMPUTER SIMULATION

Michael Foulds and Janise Richards, University of Texas Health Science Center

Medical educators have recently become interested in computer-based interactive video instruction due to the decreasing cost and increasing reliability of microcomputer hardware. Good computer-based instruction in medical education offers numerous benefits: active learner involvement in decision-making, opportunities for multiple trials without harm to real-life patients, condensing time so that learner can observe the course of a disease over long intervals, and accessibility when ever the learner's schedule permits. Recent studies have shown that interactive video instruction is both effective and efficient.

A pediatric cardiopulmonary resuscitation simulation interactive videodisc has been developed to provide practice for pediatric residents in the development of resuscitation decision-making. In this simulation, interactive video provides the visual cues critical for appropriate decision-making. The situational fidelity of the simulation is enhanced by the use of a natural language interface. The natural language interface allows the learner to enter commands (via the keyboard) written as familiar English phrases similar to those verbal commands given to a nurse in an Emergency Room.

Resident satisfaction in using this program was evaluated using direct observations and a questionnaire. Specific areas addressed include comfort levels when using the interface, fidelity of the video sequences, perception of skill level improvement, and understand of the problem presented and approach to the problem's solution.

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STUDENT ATTITUDES TOWARDS CAI IN GROSS ANATOMY

Anthony J. Frisby, Ohio State University

Student attitudes toward computer assisted instruction as a supplement or alternative to traditional laboratory demonstration were measured in this study. The population consisted of 72 (79%) undergraduate nursing students and 19 (21%) students in other allied health fields. A 27 item "Likert" scale survey was administered one week following the CAI and repeated (with 4 additional items) 6 weeks later to measure change over time.

Some results from the survey are: 14% felt that the CAI was more effective than the traditional laboratory, with 48% reporting preference for the lab. Even though only 34% of the students said they liked CAI, 53% reported they would use additional CAI programs if made available. This instrument was developed as part on the formative evaluation of the 'anatlab' series of programs being developed by Julia F. Guy.

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DESIGN CONSIDERATION AND SUBJECT MATTER EXPERT INTERACTION FOR DEVELOPING IVD/CBT SIMULATIONS

Tessie Hernandez and Jo Ann Crystal, JWK International, Inc.

Conventional methods for designing situational simulations have to be expanded when a simulation is being used to evaluate a student's decision-making skills, rather than mere recall of knowledge. Evaluation simulations must allow for all student selections by using natural feedback rather than artificial feedback that is used to direct students through a more conventional tutorial simulation format.

In the IVD/CBT project described, four case simulations were designed for third and fourth year medical students. The second and third cases are tutorial cases which provide the student with detailed feedback. The first and final cases are evaluation cases with natural feedback and a weighted, numerical scoring system that is used to establish student performance levels.

In order to design such evaluation simulations, terminal performance objectives and detailed enabling objectives are used both in the design of the case scenario and the scoring system. All scoring is transparent to the student and the simulation continues naturally so realism and concentration are never broken. At the end of the program, students are given feedback regarding achievement of each terminal performance objective and specific enabling objectives that require further attention.

Close communication between designer and subject matter experts is required to identify the performance objectives and detailed enabling objectives as well as the details of the case study. Throughout each phase of development and review, the designer must reinforce the objectives so that the final product is a true measure of the student's ability to achieve them.

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USING CAI AND IVD APPLICATIONS TO DESIGN NON-TRADITIONAL TEACHING/LEARNING STRATEGIES FOR USE IN A NURSING CURRICULUM

Mary R. Price, Hunter-Bellevue School of Nursing

Computer-assisted instruction and interactive videodisc applications are used primarily to "supplement" or "enrich" traditional class lectures. Few nurse educators use microcomputer and video disc applications to replace traditional teaching strategies even though research findings indicate that nursing students using CAI learn more in less time than those receiving traditional instruction. The SREB's (Southern Regional Education Board) Fall 1987 survey indicates that less than one -tenth of the 550 respondents perceived a change in the way students learn, or a change in the way educators teach because of computer use in their undergraduate program. How can we anticipate a change in the way students learn, when in most instances CAI assignments are mere "add ons", optional assignments that they are not really accountable for completing. CAI assignments when required, are primarily used as adjuncts, supplements to the traditional classroom experience.

The need for nurse educators to be creative in their use of computer technology is supported by the diversity of our current student population. Non-traditional teaching/learning strategies must be employed if we are to meet the learning needs of the "non - traditional" student population entering our college nursing programs. Many are adult learners with diverse experiences, abilities, and learning needs.

During the presentation, I shall outline strategies used to design and to implement Competency-Based Self-Directed Independent Learning Programs using computer assisted instruction and interactive videodisc applications. In addition, we will explore the advantages and disadvantages of a computerized learning environment and how the technology, when used creatively, will impact on traditional education. The discussion will focus on problems I encountered during implementation, integration tips, the educators role in the computerized learning environment, the student's role and their reaction to implementation of non - traditional strategies, faculty response and implications for curriculum design in the future. Participants will be asked to share their experiences in using computer technology and to identify how the use of the technology has, or will, impact on their role, the role of their learners, their curriculum and course design, and administrative policy.

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EVALUATING HEALTH SCIENCE INTERACTIVE VIDEO COURSEWARE: INSTRUCTIONAL CRITERIA

James P. Randall, Widener University

A meta-structure for evaluating Health Science interactive video courseware (IAVC) has been proposed (Randall, 1989). The literature indicate that demographics, documentation/support, instruction, program design and presentation characteristics need to be considered when evaluating interactive video courseware (DeJoy and Mills, 1989; Foshay, et. al., 1988; Henderson and Sales, 1988).

Therefore, this presentation describes elements which comprise the instruction component of the meta-structure for evaluating Health Science interactive video courseware. A review and synthesis of the literature provides a basis for analysis of the component parts. Interactive video program segments are used to illustrate selected elements of the instruction component. Discussion focuses on the need for standards for interactive video program evaluation.

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DEFIBRILLATION SIMULATION

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Defibrillation Simulation is a tutorial/simulation program designed to help teach the proper procedure for defibrillation. It is written in PC/Pilot for IBM-compatible computers with EGA graphics and 640K RAM. The program teaches proper procedure for rapid defibrillation by providing instruction and practice in decision making and arrhythmia recognition. Effective integration of fundamental assessment skills and basic CPR with the defibrillation procedure is emphasized, and information about first-line medication is available as an option. Content conforms to the Advanced Cardiac Life Support Guidelines of the American Heart Association.

Defibrillation Simulation consists of two main parts: the Tutorial mode and the Simulation mode. The program displays simulated dynamic ECG tracings and brief text descriptions of clinical scenarios on the computer screen. Within the Tutorial mode the learner may determine the course of the clinical scenarios or may have the program generate them. The learner sees a narrative description of the correct actions to take in response to the unfolding events. The Simulation mode has unscored and scored options, both accepting uncued responses which are judged by pattern matching.

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Selected Abstracts for the

Special Interest Group for Home Economics Education (SIGHOMEC)

A WRINKLE IN TIME: OR USING CAD AS A TOOL IN THE DESIGN OF APPAREL BASED ON HISTORIC TIME PERIODS

Diane Davis, Valparaiso University

The apparel industry is beginning to use CAD in the design and production of clothing. There is now a challenge to provide apparel design students with computer-aided design experience and to integrate this experience into existing courses. To meet this challenge, an electronic garment style library was created. It consists of garment segments based on styles representative of five 10-year periods, or new designs mixing components from any of the 5 periods.

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COMPUTERIZING FASHION MERCHANDISING

Nina J. Dilbeck, California State University, Fresno

The approach of the 21st Century brings with it a need for students to be educated in the application of new technologies. As with other fields, students in Fashion Merchandising need practical experiences with new technologies. One technology has now made it possible to teach merchandising techniques in the classroom with the assistance of Computer Aided Design (CAD).

Using a customized version of AutoCAD, merchandising techniques were taught to students as a laboratory experience. This lab experience was an augmentation to an existing Fashion Merchandising class. One of the major objectives was to provide students, who had minimal computer skills, with the opportunity to use computerized merchandising techniques. The focus was on merchandising techniques rather than computer skills.

None of the students had previous CAD program experience. With two hours of instruction and hands-on experience the students were able to create different merchandising scenarios; using the supplied floor plans and fixtures. Only simple commands such as "MOVE," "COPY," "ROTATE," "INSERT" were needed to complete the tasks designed. Evaluation of an entire scenario was possible by viewing the computer screen or a printout. Classroom discussions were stimulated by the various outcomes that were created for each given situation.

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THE DESIGN OF A DATABASE FOR AN HISTORIC COSTUME COLLECTION CATALOG

Frances W. Mayhew, University of Delaware at Newark

Until recently, the catalog of the University's Historic Costume Collection consisted of pages in a set of several three-ring binders. The cataloging sheets were ordered by accession number. Without knowing the accession number, it was impossible to find a garment with a raglan sleeve, an example of Alencon lace, a weighted silk, the boot panty hose or a paper dress. Using SYMANTEC Q&A and the catalog information, a database was developed making the Collection objects accessible to anyone who wished to use them. The Catalog Database Project included content analysis, development of the informational hierarchy, and inventory file design. In addition, the Project required the development of information collection forms, inclusion of students in the implementation process, and production of a User's Manual to facilitate the utilization of the Collection resources in all textile related programs.

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CUSTOMIZING CAD SOFTWARE FOR APPAREL DESIGN AND PRODUCTION

Phyllis Bell Miller, Mississippi State University

As worldwide competition stiffens, apparel manufacturers are finding it necessary to computerize their operations. Apparel design and production instructors are also striving to provide students with computer skills. Because of their relatively low cost, microcomputer CAD programs enable small firms and schools to take advantage of quick-response technology. However, little customized software is available for apparel.

AutoCAD software, which was designed for engineers and architects, was used as the basis for an apparel program. The program contains more than 40 new icon, screen, and tablet menus. The icon menus allow instant insertion of croquis figures for fashion illustration and of tools, such as French curves and L squares. Screen menus contain slopers, labels, symbols, and macros that streamline pattern making.

Several new commands have been developed using the AutoLisp programming language. They perform such functions as drawing darts; calculating button/buttonhole size and placement; and adding seam allowances. On-line help is available for all new features. Automatic slide programs explain pattern-making procedures. The program, which is in use at several leading institutions and small apparel firms, takes the work begun at the University of Tennessee in 1985 farther toward efficiently meeting the apparel industry's needs.

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COMPUTER APPLICATIONS IN THE FIELD OF HOME ECONOMICS AND DESIGN

Susan Winchip, Illinois State University

Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) is an emerging technology that is now being used by all aspects of the design manufacturing process. A computer CADD system acquisition can become an integral part of a designer's work environment. In an integrated computer system installation a multi-task workstation is capable of executing CADD graphic functions as well as utilizing automation packages to perform non-graphic functions. This electronic technology has the potential to enhance the creative and technical attributes of design and the field of Home Economics.

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Selected Abstracts for the

Special Interest Group for HyperMedia Education (SIGHYPER)

AN EXPERT SYSTEMS APPROACH TO HYPERMEDIA

Mark Chignell, University of Southern California

Hypermedia is a promising technology, but there are problems because it is difficult to construct and use. In this , we explore the relationship between expert systems and hypermedia. We show how rule-based programs may assist in building text, and in extracting information from hypertext. Research case studies are discussed.

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USING LINKWAY IN THE DESIGN OF CONCEPT LESSONS

Gayle V. Davidson, Deb Dorman, and Paul Fayfich, The University of Texas at Austin

To date, little has been shared about LinkWay, the hypermedia authoring language for the IBM environment. The purpose of this presentation is to describe and discuss the use of LinkWay by educators in the design of their own computer-based concept lessons. An example of such a concept lesson will be presented.

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DESIGNING HYPERMEDIA TRAINING MATERIALS TO OPTIMIZE LEARNING

Francis A. Harvey, Lehigh University

Lehigh University is developing an integrated hypermedia training curriculum utilizing interactive videodisc technology for Cities in Schools, Inc., a national organization dedicated to seeking solutions to problems of at-risk youth through more efficient delivery of existing social and educational services. The curriculum being developed provides extensive user control and user flexibility, through enhanced browsing capabilities and graphical and other navigational aids, in the use of a vast amount of computer-based, videodisc, and print resource materials.

Evaluation of hypermedia materials produced during the first phase of the project indicated that, in order to optimize learning from the materials, users required specific guidance in selecting, sequencing, and using material. Therefore, hypermedia training materials now being developed include "guided tours" which present structured sequences of the curriculum materials organized in specific ways. The user can thus choose between unstructured exploration and more focussed guided learning, and can combine these approaches as needed.

Organizational strategies used include structuring sequences based on the major themes of a training module, on instructional content, on learning objectives, or on the user's personal structures. This paper will describe and discuss how these "guided tours" and other organizational strategies were designed, developed, and evaluated, and how the techniques employed can be adapted for other hypermedia training applications.

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DISAPPEARING DUCKS: PROBLEM SOLVING USING HYPERTEXT

Beth Huning, Richardson Bay Audubon Center & Sanctuary

The *Mystery of the Disappearing Ducks* is a hypermedia problem solving project developed by the Richardson Bay Audubon Center, Lucasfilm, and area high school students. Apple Computer provided the equipment and training. The result is an interactive adventure in which the scenario is set around a declining duck population, and the user must discover why the ducks are disappearing. Through buttons you may interview experts and farmers, see ducks up close or migrating, read clippings, perform chemistry experiments, and even interview the students who helped make the project happen. The program is intended for small group problem solving at the high school level.

COLLABORATIVE ANNOTATION OF A HYPERBOOK ON HYPERMEDIA DESIGN

David H. Jonassen and Sherwood Wang, University of Colorado at Denver

This presentation describes a process where participants from a NATO Research Workshop on Hypermedia Design annotated the proceedings using qualified and unqualified annotations, comments, and references. Annotations were shared in an electronic mail conference. Implications for collaborative annotation of electronic hypertext are discussed.

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SELECTING MEDIA FOR USE IN EDUCATIONAL HYPERMEDIA APPLICATIONS

David C. Klugh and Francis A. Harvey, Lehigh University

A hypermedia-based training curriculum has been developed at Lehigh University for Cities in Schools, Inc. (CIS), a national non-profit organization that coordinates the delivery of human services in a drop-out intervention program for at-risk youth and their families. The hypermedia training materials are being used in the training program at the National Center for Partnership Development (NCPD), a CIS training center at Lehigh University.

This presentation defines hypermedia, reviews the media selection process for non-hypermedia educational applications, and then discusses the adaptation of the process for hypermedia with a description of the media selection process used in the CIS hypermedia development project.

Typical media selection models for instructional applications have their basis in the models presented by Gagné and Briggs (1979) and Reiser and Gagné (1983). The Reiser and Gagné (1983) model queries the designer about the objective to be taught, following a flowchart that culminates in providing choices for media selection. The "candidate media" that results from this process can then be subjected to additional decision factors related to the use of hypermedia: the use of step-motion as compared to linear motion; whether graphics will be displayed on the computer-screen or on the video-screen; whether to distribute sound resources on the two audio channels of the videodisc or to use digitized sound; and the use of new storage and presentation technologies such as Compact Disc-Read Only Memory (CD-ROM), Digital Video Interactive (DVI), Compact Disc Interactive (CDI), and rewritable optical discs.

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EXPANDING PEDAGOGICAL HORIZONS WITH A HYPERMEDIA CLASSROOM PRESENTATION SYSTEM

Michael A. Kolitsky, California Lutheran University

Our new science center contains an electronic lecture hall with a Hypermedia classroom presentation system which functions as a large screen electronic blackboard. Video images from a videodisc player and graphic images generated by a Macintosh II computer may be displayed via a video projection monitor to produce a viewing area of 140 square feet. A ColorSpace II graphics overlay board is included in this system which permits the single screen display of not only graphics and video images but also the opportunity to mix graphics and video on the same screen and portends a new form of teaching in which teachers will no longer simply "write" lectures but rather will "produce" them. Supercard has been incorporated as the controlling software for the Hypermedia presentation system and will be used to demonstrate how professional videographic techniques may be employed to expand student attention span and explore problem solving by the production of simulation and animation sequences for large screen display. This new form of teaching is not only dependent on computer technology but also on the design of the classroom itself and a discussion of the optimal building design characteristics supportive of Hypermedia presentation systems will also be included.

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HYPERTIES®: A HYPERMEDIA AUTHORING TOOL

Charles Kreitzberg, Cognetics Corporation; and Janis Marariu, University of Maryland

This seminar will provide a discussion and demonstration of Hyperties®, a software system for creating electronic books, manuals, exhibits, catalogs and other hypertext/hypermedia databases. Hyperties® is available for the IBM PC (XT, AT, PS/2) and compatibles, with input available using keyboard arrow keys, a mouse, or a touch screen. Articles may be multi-page, consisting of text, graphics, video, and audio.

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INFORMATION EXPLORATION-BASED INSTRUCTION: GUIDELINES FOR HYPERCARD STACK DEVELOPMENT

Annette Lamb, University of Toledo

The words "information exploration" have been associated with *HyperCard* since it's introduction. The words have resurrected a heated debate in the educational community about the nature of learner control. Do students flourish or flounder in a learner controlled environment? Is more or less guidance positive for learning? One of the keys to these questions regard the design of instruction. To be effective, instruction must be carefully planned. In many ways, it requires more planning to create a flexible learning environment than a structured learning environment. The purpose of this presentation is to describe these guidelines and to illustrate them with examples.

Information exploration systems can be designed to teach higher order learning outcomes and maximize learner-control. However, little has been done to develop stacks that provide students with assistance wading through data and identifying a context for this information. If students will be expected to use this information, then the designer will need to provide opportunities for application, in addition to simply giving students access to the information. These kinds of environments would allow students to control the presentation of the events of instruction without eliminating important designer control over entry skills and instructional sequence. This presentation describes and demonstrates guidelines for creating *HyperCard* information exploration-based instructional systems. Specifically, it proposes a model for instructional development of such instructional systems. This model includes identifying needs, identifying alternative methods for organizing information, identifying means of navigation, developing stack structure, and conducting formative evaluation.

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THE WORD LEARNER

Henryk R. Marcinkiewicz, Pennsylvania State University

This is a CBI framework based on a course designed for second/foreign language training of industrial employees. The instruction comprises two parts: Word Study and Word Grouping. The intent of the instruction is for practicing determining the meaning and usage of unfamiliar concepts/vocabulary.

In the Word Study screen, the concept/vocabulary item is introduced via a thought-provoking question. Several example contexts, etymological and syntactic clues, relational or analogical clues, and voiced pronunciation are made simultaneously accessible on one screen. The question challenges the learner. The contexts provide example usages. The etymological, syntactic, and relational clues provide additional information which derive from the learner's existing knowledge base. The pronunciation provides an auditory clue. Together these enable the learner to make an educated guess about the meaning and usage of the new lexical item.

In the Word Grouping screen, the learners categorize the lexical items by idiosyncratic criteria. Relationships among the items must be established in order to accomplish the grouping. The grouping strengthens the retention of the items. The simultaneous accessibility to these strategies is a unique application made possible by this computer-based rendering.

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DESIGN OF HYPERTEXT: THE EFFECTS OF USER CONTROL AND PRACTICE

Diane McGrath, Kansas State University

The research to be reported was designed to assess the effect of degree of learner control of a hypertext document on understanding of complex material. The study used three degrees of author direction (as embodied in the hypertext document): (1) guided tour through several levels of complexity; (2) guided tour through the entire complexity, with no easier levels; and (3) complete user control through the complex version of the document. High school age learners, one group with HyperCard experience and one group who did not have such experience until after the learning task, studied a social studies topic using a hypertext stack which controlled a videodisc. These groups were assessed for understanding by three means: a semantic network, the design of a HyperCard stack of their own to explicate their understanding, and application questions to assess the ability to use that knowledge (transfer). Although research has suggested) that poorer learners like user control better but do worse with it, while good learners like lesson control and yet do better with learner control, it is expected that students with practice in learning from hypertext will show better learning and will demonstrate the greatest transfer when they have the most learner control.

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HYPERCARD DESIGN AND FIELD DOMINANCE OF THE DESIGNER

Hilary McLellan, Kansas State University

This paper presents the results of a study examining learning style in relationship to how students designing in hypercard cognitively represented the structure of hypercard and the structure of the information designed into the hypercard format. This study examined how students characterized by different learning styles linked information while designing hypercard stacks. Students were supplied with database information, both textual and pictorial, which formed the basis for designing hypercard stacks. They were also provided with training in hypercard and screen design basics. This training emphasized viewing the user as an explorer accessing information via both guided tours and free exploration within the hypercard stack. Subjects were college students. The Myers-Briggs Instrument was used to identify learning style patterns. An assessment was made of how students arranged a representation of the hypercard structure and how they arranged the information presented to them for design into hypercard. These designs were assessed in terms of complexity, information navigation structure and strategies, information coherence and comprehensiveness, and overall design. The results of this study may have implications not only for hypertext designers, but also for learners confronted with a hypertext learning environment.

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STARTING FROM SCRATCH: HYPERMEDIA IN THE CLASSROOM

Louis Molinari and Lynne Levy, Glassboro State College

The functional role the computer plays in the elementary and secondary classroom is dependent upon the computer expertise of the classroom teacher, the equipment available, and time allotted to planning and development of instructional experiences incorporating the computer. When correctly applied, the computer along with related technologies can produce outstanding lessons.

When combined with hypermedia, the computer can be expanded into a tool to create dynamic and worthwhile learning environments. With some effort and lots of time, the classroom teacher can create, design, and organize quality interactive educational lessons utilizing hypermedia software which can put the computer and laserdisc player or VCR together as one highly effective delivery system.

A hypermedia environment can be created with a minimum of additional spending, utilizing the Apple II series of computers, along with a laserdisc player and interface, authoring software and videodiscs, and possibly a video overlay card. The teacher need not be a programmer since most hypermedia software provides the teacher with step-by-step instructions for lesson preparation.

Hypermedia programs for the Apple II computers which utilize a videodisc and/or a VCR to provide interactive video, include HyperStudio, Tutor Tech, VCR Companion, and LaserWorks. With the union of hypermedia technologies, not only does the teacher have the opportunity to present effective lessons, but the teacher can create and control dynamic learning environments.

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INTERACTION INSTRUCTION DEVELOPMENT USING PC TOOLBOX

Claude Ostyn, Asymetrix Corporation

A powerful new software tool for the creation of interactive hypermedia applications on IBM and compatible PCs is now available.PC ToolBox is also ideally suited to instructional applications and hypertext. The session will demonstrate how to the features of PC ToolBox can be put to work in the development of various kind of instructional materials.

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THE HYPERCARD AND QUEST AUTHORING ENVIRONMENTS: TWO APPROACHES TO CBI COURSEWARE DEVELOPMENT FOR THE "NOVICE"

Steve Purcell

As education and industry have shown greater interest in using CBI courseware, newer authoring systems have been marketed to assist instructional designers in developing these programs. This presentation, through comparisons and contrasts, will examine one MS-DOS and one Macintosh-based authoring system (QUEST and HyperCard, respectively), both of which were designed with the "novice" CBI courseware developer in mind.

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THE EVOLUTION OF A HYPERCARD STACK: NEGOTIATING SPANISH WEEDS

Lawrence C. Ragan, Pennsylvania State University

The development of courseware using HyperCard presents several unique and challenging management problems to the development team. Due to the flexible nature and the internal structure of HyperCard (i.e., stacks, cards, fields, backgrounds, buttons and scripting), revisions and modifications are more easily instituted in the courseware. These modifications can enhance the product or add to the development time and costs. This presentation will examine these issues through a look at the evolutionary stages of courseware development as well as the factors that might influence these stages.

The Computer Based Education Lab-Teaching and Learning Technologies Group at Penn State is a faculty support unit that develops courseware for faculty through the team model consisting of content experts, instructional designers, instructional programmers, and graphic artist. Through experience, the instructional design teams at the CBEL have learned much about HyperCard as a courseware development environment. CBEL has been utilizing HyperCard since the introduction of the program in 1987. Courseware developed at Penn State will serve as the model in discussing the development process and the "evolution" of an educational HyperCard stack. Currently five products in HyperCard are under development or in testing.

This presentation will include the following:
- An Introduction to The Penn State Courseware Development Process
- HyperCard as an Instructional Solution: Some Pros and Cons
- The Evolution of a HyperCard Stack
- Summary

Handouts and demo versions of HyperCard courseware will be available for interested participants as well as a list of the resources used in the development process.

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A PODIUM FOR TEACHING PHILOSOPHY

Donald Scherer, Bowling Green State University

Like professors of history, law, literature and theology, professors of philosophy teach students how to manipulate texts. Successful students in each of these fields learn how to recognize symbolic patterns: ambiguities, definitions, assumptions and conclusions, for instance. PODIUM, developed at the University of Delaware, is adaptable to facilitate classroom demonstration of these manipulations.

The pedagogical problem is that professors typically want to use students' recognition of symbolic patterns as a means to helping students to understand the content of their discipline, but students enter courses with no better than a low awareness that the patterns exist. Thus the professors are constrained to teach symbolic pattern recognition, even though it is often boring for students and even though learning it often takes time away from the course content.

A sophisticated use of PODIUM allows PODIUM itself to code different patterns (e.g., term to be defined, terms in which it is defined) so that the coding familiarizes students with the symbolic patterns, reenforces instruction concerning the patterns and demonstrates to students throughout the semester the usefulness of recognizing the pattern. The paper details the potential of such coding for acquainting students with the systemic relations of the symbolic patterns employed in a course.

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HYPERMEDIA, CRITICAL THINKING, AND DIAGNOSTIC SIMULATIONS IN THE HEALTH SCIENCES: A DEVELOPMENT MODEL

Elwin R. Tilson, Armstrong State College

This paper outlines a game-like simulation development model uses hypermedia, gaming theory, diagnostic modeling, critical thinking theory, and modified guided design looping. Computer simulations are far from a new idea in training and education. Unfortunately, simulations were historically either very elaborate, expensive, and time consuming or were not very realistic. Recent advances in technology such as hyper-text, CD ROM, scanned images, digitized sound, animation, and non-language based authoring systems have allowed for development of substantially improved micro-based simulations.

Examples from an Apple Academic Development Grant are used to demonstrate the implementation of the model. In the project, business students participate in "A Day in the Life of a Manager" simulation. All decision points in the simulation require the use of a specific mathematical analysis of business data to determine the appropriate action. Also within the gaming simulation, profits and losses for the day are used as gaming tools to keep the learner's interest high. When a performance deficiency is diagnosed, the learner is moved from to a modified guided design sequence that gives remedial instruction and models critical thinking approaches to specific information analysis. Upon completion of the guided design sequence, the learner is placed back into the simulation.

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Selected Abstracts for the

Special Interest Group for Interactive Video and Audio (SIGIVA)

PLATFORM INDEPENDENT AUTHORING AND DELIVERY OF INTERACTIVE MULTIMEDIA

Michael W. Allen, Authorware

The new CBI is alive with integrated sound, animation, video, color, graphics and text. Much is being achieved at surprisingly practical costs and developed rapidly with icon-based authoring systems. Unfortunately, most applications are tied to very specific hardware configurations. This presentation will demonstrate nearly identical full multimedia authoring and delivery on both Macintosh and Windows platforms with exchangeable courseware files.

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YOU'VE GOT A FRIEND IN THE INTERACTIVE BUSINESS: PROGRAMMING THE AMIGA FOR INTERACTIVE VIDEO

J. Wesley Baker, Cedarville College

This session introduces the Amiga as a platform for interactive video and presents the programming language and authoring programs available. An interactive video program being used at Cedarville College to introduce faculty and administrators to the technology will be demonstrated. This program resulted in the funding of an interactive design team which began work in the summer of 1990.

To provide a comparison between the authoring options available for the Amiga, three separate versions of the program will be shown at the session. One is written in Amiga PILOT, the other two are written using icon-based authoring programs which take different approaches -- VIVA and AmigaVision.

While Amiga PILOT maintains its strength as a specialized language for interactive programming it is not widely available and requires writing code. VIVA was the first interactive authoring program for the Amiga to use icons, but its structure is somewhat confusing. AmigaVision provides a flowchart-like structure, making it convenient to quickly create programs. Although neither of the icon-based authoring programs completely eliminates the need to understand programming logic, they do make the creation of interactive programs more accessible to those apprehensive about writing lines of code.

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TRANSLATING AND REPURPOSING VIDEODISCS: THE DEVELOPMENTAL PROCESS IN TAIWAN

Jiin-Tian Chyou , Tamkang University; and Bor-Nian Chang, ISTEC

This presentation will demonstrate an application of an interactive video program using Chinese translation and instructional design strategies to promote efficient learning. Software tools were developed and used to create Chinese captions. This tool can storage and generate Chinese character, and create text files by text editor. It helps the developer translate English videodisc materials on screen into Chinese texts to promote IVD development.

The structure of Chinese fonts and the development process of the program tools to facilitate translation will be discussed. The design process of repurposing "Advanced Interactive Technologies Disc" for ISTEC (Information Science & Technology Exhibition Center) in Taiwan will be presented. Design elements include level of information provided, menu variation, moving icons, on-line help animation, voice feedback, etc. These strategies is incorporated to enhance efficient interaction. The hardware and software tools used in developing the program include two PC/AT, the Chinese translation tool, graphic program, video overlay card, and a videodisc player.

The potential development of multimedia programs and future work will be presented. These include expanding design options for repurposing videodisc materials, data collection to support evaluation, and planning multimedia learning lab to promote IVD applications.

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THE APPLICATION OF FORMAL DESIGN THEORIES TO THE PRODUCTION OF VIDEO/CBI INSTRUCTIONAL SYSTEMS

Charles R. Dills and Alexander Romiszowski, Syracuse University

Abstract

Several formal instructional design models are reviewed, and
their applicability to the design of CBI/IV instruction based upon videodiscs and digitized graphics is discussed. Characteristics of the next generation of design models are specified in terms of what is needed to overcome problems currently faced in the design of such lessons using formal models. A second-generation model currently under development is presented.

Summary

Several formal instructional design models have received extensive development and verificational evaluation over the past fifteen years (A large sample of these are described in Charles Reigeluth, *Instructional Design Models)*. Also, there have been developed a good many formalized models of teaching(many of these are described in Joyce and Weil, *Models of Teaching*). The teaching models have been primarily developed for use with specialized purposes, while the design models have been rather more broadly based.

Reigeluth has argued that task analysis and instructional design should be integrated, and has produced his *Extended Task Analysis* as an example of how this might be done. The authors argue that a further integration is necessary; namely, that teaching models, design models, task analysis and media selection all should be treated as an integrated procedure. This presentation presents arguments to that effect, discusses current teaching models and design models in terms of how they relate to each other, and describe a meta-model for achieving the proposed integration. A computer program for selecting an appropriate teaching model and a design model for given objectives is demonstrated. Its extension to media selection is described, and plans for verification studies involving a variety of audiences and settings are outlined.

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STEPS FOR DEVELOPING AWARD WINNING INTERACTIVE VIDEO SCRIPTS

Deidre Emery and Steven Holder, Southwestern Cable

A successful interactive video begins with a comprehensive pre-production development strategy. This strategy anticipates design problems and corrects them immediately, thereby decreasing production costs and minimizing manpower requirements. Designing an interactive video is complicated and mentally taxing. An instructional writer must develop an interesting and complex script that entices the viewer to learn while staying within tight budget and time constraints.

The instructional writer becomes a concept juggler. S/he is responsible for script content, dialog, learner feedback loops, set design, talent directions, special audio/visual effects, as well as, shooting and editing needs. S/he decides what information is to be presented in the form of graphics, voice overs, "live" video, special effects and still pictures. Finally, s/he times each learning segment to insure flawless interaction among the laser disc, CD-ROM and desk top computer.

A systematic method for information researching, brain storming, flowcharting, labeling, writing and sorting is vital to the instructional writer's project success and personal sanity. IVID Communications, a recent Cindy Award winner, prepares its writers for the complicated task of designing interactive video scripts by providing them with a proven successful pre-production development strategy. The strategy includes: Developing master IVD questions for learner achievement; Flowchart feedback (branching) designs; Writing edits and pitfalls; Graphic and screen design options; Special Effects (audio and video); and Computerized scene sorting according to shooting and editing prerequisites

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HEALTH PHYSICS TECHNICIAN COMPUTER-BASED TRAINING

Kay Houghton and Lois Spangenberg, Los Alamos National Laboratory

Health Physics Technicians provide a critical function in scientific laboratories. They ensure safe operation of facilities, respond when problems arise, and monitor daily experiments. This task requires health physics fundamentals, and knowledge of specific procedures used in responding to incidents. At Los Alamos National Laboratory we are developing an eight module computer-based training course to train new technicians and refresh the skills of current technicians.

Part of the technician's job is to select and use complex monitoring instruments. In this showcase demonstration, the computer-based training module on instrumentation will be shown. The module allows the employee to select the correct instrument for a given assignment, perform an operational check-out of the instrument, read the instrument's meter, and accurately interpret the given meter reading.

Notable features of this computer-based training program include: A high degree of learner control through an iconic command bar; Flexibility for different learner needs; Scanned color images with graphic overlays; Storage on CD-ROM; Simulated task performance; High quality and frequent user interaction; High graphics to text ratio; Digital audio (both voice and sound effects); and Feed back tailored to the particular user response.

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IVD/CAI FOR THE TEACHING OF INTERMEDIATE LEVEL LANGUAGE

Anita M. Knisbacher, US Department of Defense

The use of interactive videodisc is taken to new levels of sophistication in a Hebrew language project designed and developed by the author as part of a 5 year DoD research effort. Based on the best of Israeli TV, the two courses, prototype and final product, employ a variety of contextual exercises—CLOZE, scrambled sentences, word chaining, sequencing, gisting, etc.—to teach all facets of the language including the four basic skills of listening, speaking, reading, and writing. Also included is an in-depth review of grammar and detailed excursions into idiomatic expressions, word formation, and the subtleties of Israeli culture.

The educational design is equally innovative and thorough. At every step, the student has the option of taking diagnostic tests to bypass virtually any part of the course. Indeed, freedom of movement through the content is unparalleled and is only limited when the student has elected to take a test.

Efficient use of time and material is encouraged by a multi-level access approach that advises the student to delve into greater detail—to drop down from exercises at the disc level to lesson level to segment level—according to performance on the various drills, exercises, and tests.

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DESIGN, PRODUCTION AND USE OF A VERTEBRATE EMBRYOLOGY VIDEODISC

Michael A. Kolitsky, California Lutheran University

A Hypermedia Laboratory was configured containing fourteen Macintosh II computers each interfaced to a videodisc player. The first videodisc produced by the University was utilized in the Hypermedia Lab to simulate microscopic study in a Vertebrate Embryology laboratory course. The embryology videodisc contains images of all the microscope slide material normally viewed in a traditional Vertebrate Embryology laboratory course. The videodisc was designed to simulate focusing and utilized computer graphics in a highly integrated manner to better assist students in their task of visualizing a three dimensional construct of the embryo from the two dimensional serial sections. The interactive videodisc learning stations in the Hypermedia Laboratory were able to substitute for microscopes and the embryology videodisc served as an easily accessible slide bank and graphics atlas for the students enrolled in the course. Student response was strongly in favor of continuing this mode of instruction in future embryology courses and recommended its inclusion in other microscope-based laboratories as well. Videodisc usage will be demonstrated and the underlying pedagogy discussed. How to design and produce a videodisc on a shoestring budget will also be covered and the institutional infrastructure necessary for a campus-wide Hypermedia effort will also be included.

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DEVELOPING MULTIMEDIA TRAINING TOOLS

Helen B. Miller and Andy McGuire, Clemson University

The presentation will focus on the challenge of developing a multimedia training tool that utilized procedures dictated by the systems approach. Two specific issues to be addressed are the importance of team building in developing a creative, productive development team and living within the constraints of the chosen software and hardware configuration.

The background for this presentation was a grant presented to Clemson University requiring the design of a stand-alone training tool that would promote technology transfer to industries in the Appalachian States. The training program uses state-of-the-art technology, such as digitized video and audio, touch-screen input, and animatics.

The food service industry was targeted because this industry has been plagued with high employee turnover, low job satisfaction, limited resources for training, poor employee-management/management-employee communication skills and low educational levels of most employees in line/staff positions. Using a multimedia training tool, individuals progress at their own pace while learning to deal with real world sanitation issues through computer simulations.

To design an effective educational program for training in the food service industry, a multi-disciplinary team approach was utilized. Instructional designers, video specialists and programmers worked cooperatively with content specialists to decide target audience, instructional strategies, and the skill competencies required by the food service employees.

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VIDEODISC-BASED HEALTH PROMOTION: EDUCATION PLUS MOTIVATION IN SMOKING CESSATION

John Noell, Anthony Biglan, and Don Hood, Oregon Research Institute

The Smoking Cessation Touch-Screen System (SCTSS) was developed as part of a program project entitled "Tobacco Reduction and Cancer Control" (TRACC), funded by the National Cancer Institute. The system is a prototype, based on an clinically-proven smoking cessation intervention that used a health educator and a short videotape on smoking cessation. The SCTSS system replicates the activities of the health educator and integrates the activities of the health educator as well as the videotaped material into an interactive format.

Patients who smoke are asked to use the system in the physician's office. It amplifies the physician's brief advice to quit and provides information on the advantages of stopping smoking. Using an approach designed to reduce resistance to the idea of quitting cigarettes, it includes motivation as an integral part of education.

The system uses a Macintosh (such as the SE20 model) to control a videodisc player in response to the detection of touches on monitor equipped with a touch-screen. Only the monitor is exposed to view. The touches on the screen replicate mouse "clicks" and are mapped to the Macintosh screen where they are interpreted as "clicks" in a HyperCard-based program.

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ENSURING INSTRUCTIONAL SOUNDNESS THROUGH SOUND EVALUTION

William W. Lee and Kenneth H. Roadman

Interactive Videodisc training, as with any type of training, will only come into its own when its effectiveness for improving performance in the workplace is documented through carefully planned and implemented evaluation activities. This presentation suggests a model for thorough, fool-proof, evaluation to enter each phase of training course production and the rationale for each activity.

For the purpose of clarity, we have separated the evaluation process into six distinct phases. These phases may not be as clearly differentiated in the production process used by individual companies but the intent is that all activities should be considered in order to tailor the final training product to the needs of the client. These six phases are: Marketing, Program Planning, Analysis, Design, Development, and Implementation.

During the Marketing Phase, the client's expectations for evaluation are established. During Program Planning, client expectations are finalized so a cost base for including evaluation in the overall product development can be established. The Analysis Phase is where needs assessment and front-end analysis are conducted. Design involves the establishment of the formative evaluation plan, validating the content, and preliminary work for summative evaluation. Evaluation during the Development Phase involves completion of the formative evaluation components in courseware production. The Implementation Phase involves the completion of the formative evaluation plan and conducting a summative evaluation. This presentation shows that evaluation is not something to be tacked on after a course has been developed. It must be woven throughout the entire production process.

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AN INSTRUCTIONAL DESIGN MODEL FOR THE DESIGN AND DEVELOPMENT OF INTERACTIVE VIDEODISC PROJECTS

William D. Milheim and Harold J. Bailey, Bloomsburg University

While a number of well-known instructional design models exist for the development of computer-based materials, few specifically address the issues relevant to the design and production of instructional, interactive video programs. With the lack of information in this area, the Institute for Interactive Technologies at Bloomsburg University developed a design model specifically focused on the development of interactive video lessons.

This presentation will include an overall description of the model, its theory bases, and its application in interactive video projects. Specific topics will include: 1) the overall coordination of a project, 2) design team responsibilities, 3) working with subject matter experts, 4) use of project timelines and milestones, 5) use of content outlines, 6) flow-charting, 7) scripting, 8) guidelines for screen design and menu usage, 9) documentation, and 10)project evaluation. The presentation also includes a number of examples which demonstrate the model's use in various settings in education and industry.

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A VIDEODISC FOR THE TEACHING OF FRENCH LANGUAGE AND CULTURE

Donna Mydlarski, The University of Calgary

Developers at the Universities of Calgary and Guelph have designed an interactive videodisc to teach French as a second language firmly rooted in a French Canadian cultural setting. It was decided to use top quality video from the film library of the Canadian Broadcasting Corporation and add to a fifteen-minute film a variety of slides and drawings. A wide range of audio and computer-based materials have also been added.

VI-CONTE means a "video-story" and uses narration for teaching aural comprehension with cultural materials derived from and supporting the animated short film which is at the core of the program. The basic principle is the coordinate presentation of a sentence with a clarifying situation.

The disc begins with an iconic situation, a film without words (although the music and sound effects are very expressive). The situation being understood, the program goes on to supply concrete vocabulary. Then, once word has become attached to image, simple sentences in the form of questions reinforce the isolated words and begin setting them in verbal context. There is no writing on the screen. Three or four verbal choices are spoken, with only written letters appearing on the screen. The student types in the letter corresponding to the choice. Feedback is completely oral.

The first process is called "observation". It is followed by a process called "narration", whose overall linguistic goal is to create a grammatical framework for the data learned in "observation". First, a verbal story line is attached to the visual story. Written questions are asked about the story as well as about inferences the student may make from the visuals. Then the student hears three synopses of the verbal story line which are exploited via cloze, multiple choice and dictation with written feedback.

The final process is called "reflexion". An illustration of the traditional French Canadian legend, La Chasse Galerie, is presented on the screen. The student has a choice of two sound tracks to practice oral comprehension. The first is in standard CBC Canadian French; the second in colloquial Quebec speech, with a regional accent. Finally, there are photos of the Quebec City carnival, followed by art slides and many photos of modern day Montreal and Quebec City. This is a multi-level disc directed at several different learning populations. There is no expectation that learners will pass from "observation" to "reflexion" by using only the disc.

Note: The support of the following is gratefully acknowledged: Canadian Studies Directorate, Department of the Secretary of State (Canada); Canadian Broadcasting Corporation; The University of Calgary, University Radio and Television Committee and Special Projects Fund of the Board of Governors. C'est aux admirables images de Frederic Back que ce projet pedagogique doit son inspiration et sa realisation.

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EFFECTS OF VARIATIONS IN LESSON CONTROL ON CHILDREN'S CURIOSITY AND LEARNING ABOUT ART FROM INTERACTIVE VIDEO

Marilyn Johnstone Plavocos, Syracuse University

Encouraging curiosity in young learners is an important task for educators yet, in the area of interactive video, literature related to this topic is lacking in empirical research. Most research studies involving interactive video and learner control have been conducted with sophisticated learners (Balson, Manning, Ebner & Brooks, 1985; Gay, 1986; Hannafin & Colamalo, 1987; Gay & Trumbell, 1988).

Issues related to lesson control can have different implications for children (Hannafin, 1984). This study investigated the comparative effectiveness of variations in lesson control on children's curiosity and learning from interactive video and whether interactive video can be utilized to both stimulate the important scholarly attribute of curiosity and provide adequate direction and guidance for young learners.

The study used a post -test-only control group design with three experimental treatments. The lesson content provided by a subject matter expert in art education, was designed with no text to accommodate subjects with limited reading experience. The subjects were one hundred first and second grade suburban elementary school students who were randomly assigned to one of the four study groups.

The Designer-Controlled Group followed a linear path through the lesson, the Learner-Control Group had control of content, sequencing, pace, and remedial needs, the Learner-Control with Advisement Group was given the same opportunities to explore the lesson as the learner-control group but "advisement" strategies were employed. The Control Group received only the post test. Study results will be part of the ADCIS presentation.

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RESULTS OF THE FIELD TEST EVALUATION OF AN INTERACTIVE VIDEODISC SCIENCE CURRICULUM WITH A FOCUS ON STUDENT AND TEACHER PERCEPTIONS AND IMPLEMENTATION

Wilhelmina C. Savenye, The University of Texas at Austin

This presentation will describe the field test of the Texas Learning Technology Group's full year videodisc and computer-based high school physical science curriculum. The test was conducted in 37 school districts in four states. The primary focus will be on student and teacher attitudes toward the IVD curriculum, and how it is actually being used in the classroom.

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TEACHING INTERACTIVE VIDEO DESIGN AND DEVELOPMENT: METHODS AND MODELS

Wilhelmina C. Savenye, The University of Texas at Austin

Interactive video development is increasingly being taught in Instructional Technology programs. This presentation will describe a two-course sequence developed at the University of Texas at Austin. The curricula and goals, course procedures and projects, models for teaching, methods to encourage and support interactive video teaching and research projects, and recommendations and resources for teaching interactive video will be presented.

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INDIVIDUALIZING INTERACTIVE VIDEODISC INSTRUCTION

Karen Tichy, Illinois Institute of Technology

The visual design field uses visual representation such a diagraming, mapping and visual models to aid in the analysis of design problems. This designer has applied design methodology to IVD design. Using these methods, a model of learning was established. The model consists of the 1) user (or learner); 2) the learning system (be it traditional classroom or computer based); and 3) information or content. Each of these components were further analyzed and characterized. For instance:

A component of the learning system is the media or technology used to present information. Since IVD is the media being used in this case, further analysis of that media was done. This analysis identified characteristics of IVD that change the way people access and understand information. It increases the choices of available sign systems (forms of information such as words numbers, pictures, and diagrams). It increases the variety of activities, physical and mental, through which a user can interact with information. And, it makes it possible for the user to control both the sign systems and the activity through which information is accessed and understood.

These characteristics make it possible for the user to adapt his learning experience according to his/her interests and cognitive preferences and educational goals.

This thesis proposes a user controlled learning system capable of presenting information according to user affective and cognitive needs and desires. The system puts the user in control of the presentation style. The presentation style refers to the esthetic sense and method of presentation (straightforward lecture, or entertaining dramatization). It puts the user in control of the mode or sign system used to present the information and it coaches the student to make effective decisions about how to access, manipulate, and think about information.

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EVALUATION OF A LABOR AND DELIVERY VIDEODISC SIMULATION

Elizabeth E. Weiner, Barbara Gilman, and Jeffry Gordon, University of Cincinnati

The purpose of this evaluation project was to determine the impact of an interactive videodisc (IVD) simulation in labor and delivery on clinical confidence and learning with junior level nursing students.

Research questions addressed were:

- Is there a difference in clinical confidence and learning between students completing an IVD simulation in combination with a clinical experience versus those students completing only a clinical experience?
- Does the order in which the students receive the IVD program affect the clinical confidence and learning outcomes?
- Following completion of the IVD program, what overall evaluation comments do students have?

Two clinical groups of students were created. Both groups were pretested on knowledge and clinical confidence. Group 1 completed the IVD program before providing clinical care in the labor setting. Group 2 received a traditional clinical experience first, followed by the IVD program. Multivariate analysis of variance supported the following conclusions:

Students completing an IVD program plus the clinical experience had significantly greater clinical confidence and learning than those students completing only the clinical experience. The order of the IVD program made no significant difference in clinical confidence or learning, but the IVD appeared to contribute more to clinical confidence than did the clinical experience.

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STUDENTS AS PRODUCERS: A MULTI-MEDIA PROJECT FOR MIDDLE SCHOOL MATHEMATICS, SCIENCE, AND SOCIAL STUDIES

Michael Young, University of Connecticut; and
William Corbin and Susan Williams, Vanderbilt University

An investigation of the topic of students as producers has been proposed. The project, supported by IBM, McDonnell Foundation, and Vanderbilt University would take students from the position of learners to being producers of knowledge in 4 steps. First, students become familiar with multi-media technology. Second, students receive instruction in mathematics, science, and social studies using the multi-media formats they will later produce, particularly the "Jasper Series". Third, students choose, plan, and research topics introduced through instruction using conventional and electronic resources (including fax, e-mail, and databases). Finally, students create presentations of their findings using a combination of videotapes, audiotapes, videodiscs, and hypermedia programs.

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Selected Abstracts for the

Special Interest Group for Management Issues (SIGMI)

AN EXPERIENTIAL FRAMEWORK FOR EVALUATING SIMULATIONS

Wayne Anderson, JWK International

Simulations are often judged as "successful" based on their degree of acceptance by the learners involved. Yet simulations are often employed in projects with no criteria for evaluating experiential components such as identification and participation. Decisions to use simulation in training often are dictated by client desires or budget constraints rather than their effectiveness for the learning process. How does one structure design in the beginning to promote learner acceptance of simulation? How does one measure experiential components of a simulation? This presentation suggests a framework of three interpersonal variables for evaluating the effectiveness of simulations and implications for future design. Methods for achieving learner acceptance must consider what helps the learner "belong" to the experience. Simulations should mimic the ways in which people process information as well as solicit and give feedback. These methods must be integrated into the design process before "development" begins.

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TEAMWORK: GROUP DEVELOPMENT OF CBT

Kay Bonham and Karen Droms, Goal Systems International

We will begin the presentation with a group discussion of the benefits of using a team for developing computer-based training. We will ask participants to describe anecdotes of their experience with the use of teams in CBT development. Building on these contributions, we will generate a list of the advantages and disadvantages of group development of CBT.

Next, we will present several principles of group communication. We will show how effective use of these principles will enhance the advantages of group development while minimizing the disadvantages. To illustrate these principles, we will conduct several exercises with the participants. These exercises will show how group communication and group structure affect group performance.

At this point, the participants will split up into several development teams. Each development team will be given the same project assignment. We will give each participant a profile of the rile he or show will play within their development teams. This profile will include a list of each participant's personal goals. The teams will have the same project assignments, but different participant profiles. We will then ask each team to develop their team goals. We will show how personal goals of individuals affect the goals of the team and how a project manager can recognize these hidden agendas and minimize their affect on the group goals.

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OUTGROWING THE COTTAGE: DEVELOPING COMPUTER-BASED TRAINING ON A LARGE SCALE

Robert C. Fratini, AT&T National Product Training Center

In 1986, AT&T Product Training Services began the development of its first large-scale computer-based training curriculum, to support maintenance training for its flagship central office product, the 5ESS Switch(R). At this time, CBT development expertise resided primarily in a handful of CBT developers who lacked detailed product expertise. Tools and processes evolved to facilitate the hand-off of content from content specialists to CBT development specialists.

By 1988, we had become victims of our own success. The CBT curriculum had been successfully implemented worldwide, but the costs of maintaining and adding to the curriculum were perceived to be unacceptable, especially in terms of the life cycle of the 5ESS Switch product itself.

In 1989, the Electronic Training Solutions (ETS) department of PTS began the development of a strategy to facilitate the large- scale development and maintenance of computer-based curricula. This involved an analysis of the PTS organizational, political, and training funding structures. Processes were then developed taking these structures into account, and CBT development tools were selected or developed to support the processes. The goals of these changes were to minimize the need for the development of interim products and product hand-offs, while maintaining the presence of CBT specialists in those areas deemed by PTS management to be most appropriate.

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DEVELOPMENT AND IMPLEMENTATION OF A COMPUTER-BASED DATA MANAGEMENT SYSTEM FOR NOVICE COMPUTER USERS

Francis Hensley, University of Georgia; and Chris Peters, Clemson University

This presentation will demonstrate and describe the development of a computer-based management system for members of a national network of educational project managers. This application was developed using a sophisticated data base management system, *Fourth Dimension*, especially for use by novice computer users. The system exploits the visual interface and ease of use of the Macintosh computer and allows users to track project related activities, generate required reports, and otherwise efficiently manage the daily operations of their offices. The presentation will focus on the use of such programs to manage educational projects and to make project decisions based on accumulated data as well as the process of designing, developing, and implementing such applications.

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MANAGING CONFLICT IN CBT PROJECTS

James R. Hutton, J.R. Hutton & Associates

As a manager, do you realize you could be spending up to 20% of your time managing conflict? Conflict occurs at all levels and between all participants in a CBT project. This session will enable you to recognize that conflicts are not all negative and often have positive outcomes. You will also be able to identify elements of a conflict, sources of conflict, and outcomes. Participants will be asked to apply a 5 step conflict resolution process during the session.

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CASE MATERIALS FOR MANAGEMENT TRAINING

Frederick G. Knirk, University of Southern California; and DeLayne Hudspeth, University of Texas at Austin

Case study methods are excellent for many levels of computer-based training, ranging from targeted management issues, to high level problem-solving. This session will focus on: 1) the types of training objectives that can be taught by case studies; and 2) how to develop and use case materials for those objectives.

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THE COST OF NOT TRAINING WITH COMPUTERS

Frederick G. Knirk and Mary Pinola-Kenny, University of Southern California

While training programs are expensive, the cost of inadequately or inappropriately trained employees can cost MORE; the cost of NOT training can be much more than the costs of providing training. One of the best sales tools we have for selling CAI is to demonstrate to our clients or employers that training is relatively inexpensive and cost-effective. In this session, we will demonstrate how you can use this procedure to sell your computer-based training programs.

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THE ROLE OF THE SUBJECT MATTER EXPERT IN THE DEVELOPMENT OF CBT

Henry H. McCaslin, Jr. and Patricia M. Boord, FBI Academy

Computer Based Training professionals have long advocated a team approach to CBT development. Although teams vary in composition from organization to organization, the commonality among them remains - "one group working toward a common goal." Building a team is not an easy feat. Team members are selected on professional experience and their ability to work in a team environment. Yet is appears that one team member, the Subject Matter Expert (SME), is very often selected solely on the merits of "knowing a lot about the subject."

Many managers unintentionally select SMEs ill-suited for the CBT development team. This often occurs because there is a lack of understanding, both by managers and the SMEs themselves, on exactly what the SME's responsibilities are. This presentation will focus on the role of the SME in the CBT development process. It will examine questions such as, does the potential SME possess personal and professional attitudes that could be detrimental to the successful completion of the project? Is the SME fearful of computers? What are the benefits to being an SME?

The presenters have worked on numerous projects with a wide variety of SMEs. Some were very fearful of computers. Some did not want the computer to "teach their class." And others, just did not work well in a team environment. As a result of these experiences, the presenters have been able to identify characteristics and traits that can enhance the SME's role in CBT development. Management's awareness of these traits and characteristics can greatly influence the success or failure of CBT development and implementation.

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EVALUATING TRAINING AND DEVELOPMENT PERSONNEL: METHODS, LEVELS, AND PITFALLS

William H. Wheeler, Jr., The University of Georgia

Often non-traditional in terms of process, power relationships, and outputs, the modern training and development function represents a real challenge to management when the productivity and contribution of personnel must be evaluated. An staff member may be working on several projects, and have varying levels of responsibility which change on an irregular basis. Responsibility for completion of critical elements of a project often shifts to external organizational components. Evaluating productivity for a particular person on a particular project can be difficult. Factors such as creativity are hard to pin down.

To manage the training and instructional development function effectively, the training manager must have accurate information. This paper will present a multiple-methodology process for evaluating training and development personnel, suggest and explain appropriate levels of personnel evaluation, and point out a number of pitfalls.

Managers often dismiss the idea of multiple methods for evaluating personnel, arguing that the process is too time-consuming. This paper will argue that the lack of a system that provides evaluative tracking of staff activity and **continual** formative evaluation feedback is one of the most important sources of **managerial** productivity loss. The annual evaluative hour supplemented by weekly yelling about unpleasant **surprises** may be the least efficient process of all.

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Selected Abstracts for the

Special Interest Group for Music Education (SIGMUSIC)

DEVELOPMENT OF A COMPUTER-BASED COLLEGE PITCH MATCHING TEST

Ioanna E. Etmektsoglou, University of Illinois-Urbana-Champaign

A Computer-Based College Pitch Matching Test (CCPMT) was developed in 1989 and included single pitches, melodic intervals, motives and short phrases derived from well known compositions of different styles. The test was administered individually to college freshman students in music education at the University of Illinois at the beginning of the 1990 academic year.

The purpose of the test was to evaluate the pitch matching ability and tonal memory of the students. The 30-item test was pilot tested off-line and on-line with high school and college students before being administered to the test subjects. The testing completion time was approximately 12 minutes per subject. A minimum of fifty subjects were selected for the research project. In addition to the performance test, students completed a questionnaire which was intended to collect information on their previous musical experiences in both formal and informal educational settings. Test equipment included a DELL 286 computer, a Casio MT-240 MIDI Keyboard, and an AFI Pitch Board. The microphone input was converted to digital MIDI information for student assessment. Data were analyzed for accuracy with 1 cent discrimination. Sampling rate of the AFI interface was 1500 samples/second. Students received evaluation feedback on accuracy of pitch performance.

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THE USE OF INTERACTIVE VIDEODISC IN ACQUIRING MUSIC TEACHING COMPETENCIES

Mary A. Leglar and Robert W. Placek, The University of Georgia

Most states in the U.S. now require candidates for teacher certification to pass formal competency-based tests on planning and presenting instruction. This has reinforced the profession's awareness of the need for field-based experiences in the training of teachers. However, many college music education departments find it difficult to schedule and supervise extensive pre-service teaching.

To supplement field-based teaching experiences, a complete observation program was developed using a series of interactive videodiscs of music teachers in actual classroom settings. Taped segments were carefully chosen to cover each classroom competency tested by a representative state certification instrument. The taped lessons were not rehearsed, and do not represent "perfect" lessons.

Each segment was analyzed by a group of experts to identify teacher behaviors which demonstrated, or in some cases failed to demonstrate, the required competencies. The analyses of the video segments were validated by state certification officials. A computer program was developed to control the video playback equipment and guide individual students through a detailed observation and analysis of the taped lessons. Results of a pilot study suggest that interactive video observations improve students' ability to analyze teacher behavior, and provide an efficient means of supplementing pre-service field experiences.

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MUSICAT: AN ADAPTIVE TESTING PROGRAM TO ASSESS MUSICAL ABILITY

Walter P. Vispoel, Don Coffman, and Dawn Scriven, The University of Iowa

One of the most significant recent advances in measurement technology is the development of computerized adaptive tests. Research assessing the feasibility of adaptive tests indicates that adaptive testing procedures require an average of 50% fewer items to yield reliabilities and validities comparable or superior to those of conventional tests (McBride & Martin, 1983; Moreno, Wetzel, McBride, & Weiss, 1984; Urry, 1977; Weiss, 1982). These promising results have led to the development of the first operational adaptive tests which presently include adaptive versions of a) standardized aptitude tests, such as the Armed Services Vocational Aptitude Test Battery (Allfred & Green, 1984; Sympson, Weiss, & Ree, 1982) and the Differential Aptitude Tests (McBride. 1986), b) college placement tests (Stocking, 1987), and c) achievement tests for elementary and high school students developed by the Portland Public Schools, the Montgomery County (MD) Public Schools, and the WICAT Systems Corporation (See Rudner, 1989). These tests are similar in that they all use visually-administered items.

In this presentation, the features of an computerized adaptive testing program designed to assess musical ability will be demonstrated. This program is the first operational adaptive test of musical listening skills to be implemented on a microcomputer. It also is the first computerized adaptive testing program that measures a cognitive skill using aural rather than visual stimuli.

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USING CD-ROM AND CBT TO DEVELOP LISTENING SKILLS

Ernest Woodruff and Phillip Heeler, Northwest Missouri State University

Perceptual listening is of prime importance to the musical experience; therefore, an important goal of music literature and appreciation classes is to develop the listening skills of the students. The presenters have used principles of Keller's Personalized System of Instruction (PSI) to encourage the mastery of aural (listening) skills in a college music appreciation course. Implementation of PSI was accomplished by specifying aural objectives and then testing the mastery of these objectives by using an interactive videodisc workstation. Due to widely varying backgrounds and abilities, some students easily passed the aural tests at a prescribed criterion level while others were not able to pass aural tests after many attempts.

The presenters are currently engaged in a research project which explores the use of an expert system in conjunction with the audio function of CD-ROM to help students master aural objectives. This session will describe how CD-ROM technology can be used to present tutorials which track learner performance and provide appropriate remediation. Details of the results of a pilot project will be shared with the audience.

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Selected Abstracts for the

Special Interest Group for PILOT
(SIGPILOT)

INTEGRATING PC-PILOT WITH EXPERT SYSTEMS: GRAPHICS, EDITING, AND CONSULTATION

Ping-Cheng Chao, University of Georgia

Most expert system development tools on the market today have some sort of capability for displaying graphics, but those features provided by the tools are not sophisticated enough to increase user friendliness or offer a delivered system that has a polished professional look. A Media Selection Expert System will be developed by using PC-PILOT programs to display graphics and demonstration programs.

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SIMULATING DYNAMIC ECG TRACINGS WITH PC/PILOT

John A. Stewart, HealthWare Corporation

In CAI involving electrocardiogram (ECG) interpretation, the display of ECGs is often limited to static tracings. Displaying dynamic ECG tracings can significantly increase the realism and usefulness of certain types of programs, e.g., simulations of cardiac emergencies.

The presentation outlines a method for simulating dynamic ECG tracings on the computer screen. The method uses EGA graphics, the EGAPIQ utility from the PC/PILOT Advanced Feature Library, and a RAM disk (virtual disk) set up in the system configuration file. Rapid access to a large number of ECGs is possible, and each tracing can be displayed with continuous motion for as long as necessary.

Participants will be shown how to set up a RAM disk and the method will be explained with reference to a sample ECG display subroutine, copies of which will be distributed to the audience. The presentation will include guidelines for keeping the speed of the ECG display constant with various CPUs.

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CREATING A STRUCTURED PILOT CAI LESSON

Marianne E. Yoder, Northern Arizona University

For the beginning programmer, creating code in a logical, easy-to-debug manner can be overwhelming. Although PILOT is a relatively straight forward authoring language, the manual which comes with PC PILOT presumes that the PILOT author already understands the logic of programming. PILOT is forgiving, so that loosely written programs will run properly. However, such programs may prove difficult to modify when further testing of the CAI program demonstrates the need for modification of the instructional presentation. This presentation will demonstrate several strategies the beginner programmer can use to produce structured PILOT code. The programming techniques demonstrated will help organize the CAI lesson into manageable sections, decrease the amount of time necessary writing code, improve the readability of the code when future revisions are necessary, and make debugging easier. Code from a sample program demonstrating a menu, random selection of questions, and pop-up dialogue boxes will be available.

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Selected Abstracts for the

Special Interest Group PLATO Users' Group (SIGPUG)

LESSONS LEARNED IN APPLYING NOVANET TO ALTERNATIVE EDUCATION (BASIC SKILLS DEFICIENT AND DROPOUT STUDENTS)

A. Sidney Alpert, University Communications, Inc.

Various schools and programs in and around the country have now had four years of experience in using NovaNET to solve the ever increasing high school dropout and basic skill deficiency problems (alternative education). This presentation describes the various problems encountered, the existing NovaNET based solutions, the historical results, and suggestions for improving NovaNET implementation in these areas.

This presentation will include the following topics: a) Sites and Programs; b) Facts and Figures; c) Implementation Structures; and d) Lessons Learned

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INNOVATIONS IN TRANS-TUTOR

Richard W. Blomme

New ideas associated with the development of the experimental Trans-TUTOR system will be discussed. Focus will be on the underlying structure of the language and changes which make it simpler and more flexible than the TUTOR language from which it evolved. Issues associated with transportability of material will also be discussed.

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HOW TO DELIVER INDEPENDENT STUDY (CORRESPONDENCE) COURSES VIA NOVANET

Bruce A. Cameron

As alternative education looks for solutions to graduating dropout and remedial high school students, an open entry, open exit, self paced method of getting student through course requirements is needed. Because traditional correspondence courses have problems motivating students and providing interactive instructor contact, many students do not succeed. This presentation will demonstrate the feasibility of successfully delivering interactive independent study courses to students via NovaNET.

Topic covered in this presentation will be:

- Prerequisites to Developing an Interactive Independent Study Course, including instructors, learning objectives, scope and sequence, textbooks, learning activities, appropriate NovaNET lessons, assessment and competency testing questions, and grading;
- Determining How to Implement Learning Activities, both on line and off line, and the strengths and weaknesses of the computer in accomplishing specific learning activities;
- C-router (An Open Architecture Student Management System), including syllabus entry, assessment sequencing, and student data management;
- Student Teacher interaction, including student/teacher electronic mail, live conversations, and monitor mode (As a "networked system", courses can be delivered over long distances and under abnormal circumstances such as for homebound students. Location of students and teachers is immaterial), and interaction with other students in the course;
- Creating New on Line Materials Specific to the Course, such as Testing 123 (on line tests), CFP drills (the distinction between rote and conceptual learning), and developing your own tutorial lessons.

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NOVANET SHOWCASE

Celia Kraatz, University of Illinois

The purpose of the NovaNET Showcase is to provide an opportunity for persons using NovaNET or PLATO to demonstrate courseware, curricula, software, use of peripherals, programming techniques, etc. Each presentation will take place at a terminal and will be 10 to 15 minutes long, with time for questions. Presentations will be concurrent, and will be repeated.

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Selected Abstracts for the

Special Interest Group for Theory and Research (SIGTAR)

DESIGNING THE USER INTERFACE AS GENRE: RESTRICTING CONTEXT FOR MEANING AND BEHAVIOR

Terence C. Ahern and Jamie Myers, The Pennsylvania State University

The capacity of short-term human memory requires that large amounts of information be linked by indexing terms or experiences that become implicit referents. These implicit referents allow humans, when confronted by novel situations, to model the new uncertainty by creating analogies or metaphors from previous experiences. Developers of courseware, therefore, must be aware that any instructional context such as CAI will evoke implicit referents in the learner. These referents provide the learner a model of the appropriate structure of lesson content and interactive behavior.

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USING CAI TO INCREASE FLEXIBILITY IN PROBLEM-SOLVING

Terence C. Ahern and Fernando Senior, The Pennsylvania State University

Research has found that a learner's ability to solve problems can be constrained by functional fixedness, habit, or even their world view. This study assessed the effectiveness of an alternative type of courseware designed to increase cognitive flexibility in problem-solving. It was hypothesized that if learners had opportunities to solve reading problems from a variety of theoretical perspectives, their flexibility in problem identification and solution would be enhanced. This software also incorporated an alternative model of assessment by providing learners with open-ended problems and sample expert solutions in the teaching of word identification skills.

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SCREEN DESIGN: LOCATION OF INFORMATION AND ITS EFFECTS ON LEARNING

Macarena Aspillaga, Westlake School; and Zhongmin Li, Utah State University

This study examined the effects of screen location of information displayed in CAI lessons on the retention of information. Sixty undergraduates were randomly assigned to one of three text display treatment conditions: 1) text display relevant to graphical information; 2) text display at the upper middle section of the screen; and 3) random text display. Results indicated that displaying text at a consistent location or relevant to graphical information facilitated learning.

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PARAPHRASING IN CAI

Catherine Augustine and Kyle L. Peck, Pennsylvania State University

Traditional CAI generally involves a learner responding to objective-based questions requiring multiple choice or short answer responses. However, paraphrasing strategies are emerging as a potentially important tool for CAI designers. Perhaps, as Jonassen (1988) proposes, paraphrasing forces the learner to process information in a way that requires more "generative processing" of information, leading to increased retention.

This study investigated paraphrasing in CAI and its impact on retention, comparing paraphrasing to "short-answer" and control conditions. Sixty-five university student volunteers were divided into three groups. Thirty comparable instructional objectives were randomly assigned to three sets. A balanced design (illustrated below) caused one-third of the students to paraphrase objective-related content for each set of items, to respond to short-answer questions for another set, and to perform no additional processing on a third set. Therefore, each of the thirty objectives was attempted by all 65 students (one-third under paraphrasing support, one-third under short-answer questions, and one-third with no additional processing) and all 65 students participated in each condition.

	Group 1	Group 2	Group 3
Question Set A	Paraphrase	Short Answer	Control
Question Set B	Short Answer	Control	Paraphrase
Question Set C	Control	Paraphrase	Short Answer

Results support the use of paraphrasing in CAI.

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A STUDY OF THE EFFECTS OF ORGANIZATIONAL CUES, GLOBAL ITEM PLACEMENT, AND ADMINISTRATION MEDIUM ON ITEM RESPONSE PATTERNS OF A COURSE EVALUATION INSTRUMENT

Mary J. Boyce, Texas A&M University

In this study the effects of organizational cues, global item placement, and administration medium on student responses to questions was investigated. The questions were part of a course evaluation instrument. It was found that students do answer questions differently when completing the evaluation on a computer, and when provided organizational cues.

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A MODEL FOR COMPUTER-MEDIATED COOPERATIVE LEARNING: RESEARCH FINDINGS AND ISSUES

David W. Dalton, Kent State University

This presentation will summarize research findings related to computer-based cooperative learning and propose an agenda for future research. The following general areas will be addressed: 1) The definition of cooperative learning; 2) The rationale for implementing cooperative programs; 3) Research findings; 4) A taxonomy for classifying current and future research projects; and 5) A review of methodologies and dependent variables for research in computer-mediated cooperative learning.

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THE RELATIONSHIP AMONG LEARNING STYLES, ATTITUDES, AND STUDENT PERFORMANCE IN A COMPUTER APPLICATIONS COURSE

Gayle V. Davidson and Wilhelmina C. Savenye, The University of Texas at Austin

While researchers have studied the effects of students' learning styles and attitudes toward computers, to date there has been little research on the relationship between these variables. This presentation will describe the rationale, methodology, and results of a study which extends learning style research by investigating the relationship among learning styles, attitudes, and performance in a computer applications course for preservice teachers.

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THE RELATIONSHIP BETWEEN TASK ANALYSIS AND KNOWLEDGE ACQUISITION

Charles R. Dills and Alexander Romiszowski, Syracuse University

Abstract

The fields of knowledge acquisition and task analysis have not been well-integrated, and not much cross-fertilization has so far occurred. The authors explore the possibilities for such integration, pointing out how each field can benefit from the other, and identifying kinds of research which would benefit both areas. The alternative meanings of "knowledge acquisition" as used in the two fields are clarified and contrasted.

Summary

The authors argue that knowledge acquisition, a branch of computer science, and task analysis, a branch of instructional development, have much in common. After presenting some preliminary arguments to this effect, the authors list ways in which task analysis could benefit from an adoption of current knowledge acquisition methods and ways in which knowledge acquisition could benefit from a greater knowledge of task analysis and the adoption of many of its methods.

The possibility of other benefits from cross-fertilization between instructional development and computer science is discussed. Chief among these is the development of new ways to structure knowledge. Research on intelligent tutors has shown ways in which knowledge can be structured so as to represent optimal learning patterns for interactive instruction.

There are also some dangers in the unsystematic fusion of instructional development and computer science concepts and methodologies. The authors have made a distinction between "knowledge acquisition" in the task analysis sense and "knowledge acquisition" as learning that points out how loose usage of the terminology often leads to confusion. As an example of such practical confusion, the recently-coined concept of "situational cognition" is analyzed. Implications for research and development in both the fields in question are discussed.

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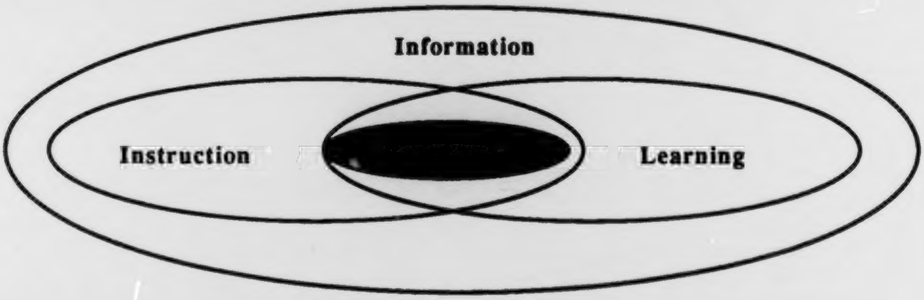
LEARNING FROM HYPERMEDIA: IS THIS AN INFORMATION, INSTRUCTIONAL, OR LEARNING MEDIUM?

Barbara L.Grabowski and Ruth V. Curtis, Syracuse University

Hypertext was defined by Nelson (1960) as a means to "connect a nonlinear body of information with 'links' between documents that guide readers from one to another" (cited in Osgood, 1987). Hypermedia, on the other hand, is the "logical extension of hypertext, encompassing graphics, animation, video, sound, and so on" (Osgood, 1987). Because of a tremendous increase in information that is available to our society and the ease with which "stacks" are created, developing hypermedia databases has become a very attractive means for presenting this information. However, herein lies a serious issue. What is being passed off as instructional may, in fact, be simply information.

Information has been described as a process, a flow of messages (Wilson, 1988) with many functions, one of which is to instruct (MacMullin and Taylor, 1984). **Instruction**, on the other hand, may be defined as a way of organizing and sequencing information for the learner which may include any one or all of a number of essential elements such as presentation of information and provision of examples, practice and feedback (Reigeluth, 1983). **Learning** results from active cognitive processing of information. However, information is not always instructional, nor does viewing information always result in learning. Finally, instruction does not always cause learning nor does learning always require instruction. Fleming and Levie (1978) classify the difference between instruction and learning according to the locus of the activity; that is, instruction occurs outside the learner while learning is the result of internal processes within the learner. The relationship among these phenomenon may be represented by the diagram below. The shaded area represents the convergence of the three.



From this conceptual mode, we will discuss factors to consider in the design of a hypermedia stack for information, instructional or learning purposes. These factors can also be used for evaluating existing hypermedia "lessons" to determine if they are, indeed, informational, instructional or learning tools.

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CBI TECHNIQUES FOR ENCOURAGING ACTIVE MENTAL PROCESSING

Barbara L. Grabowski and Eileen Schroeder, Syracuse University

An important current focus of research is examining instructional and learning strategies from two perspectives: one which affects the organization of information to be learned, and the second which affects who does the organizing--the instruction itself, or the learner. From the first perspective, research has been conducted mainly in two broad areas: one which relates to-be-learned information to existing cognitive structure and the second which affects the structure and organization of the information. The theoretical basis for this research is based on cognitive theory, information processing, and schema theory (Mayer, 1979, Rumelhart, 1980). Examples of instructional/learning strategies which are influenced by this research include the use of analogies, concept maps, pattern notes, use of examples or main ideas, to name only a few. The second perspective involves the question of who does the connecting or organizing of information--the instruction or the learner. Researchers are investigating the effect of providing the link or organization of the information for the learner in a supplanted, instructional way, vs. the effect of having the learner generate those links for him/herself. In 1966, Rothkopf began advocating the use of mathemagenic (those that give birth to learning) strategies that evoke active cognitive processing (see also Rothkopf, 1970). Following this reasoning, Wittrock began writing about generative learning (Wittrock, 1974a, 1974b). In a generative mode, learners accept responsibility for examining the underlying structure of the information to be learned and generate their own relationships among concepts and to their own knowledge (Wittrock, 1974a, 1974b, 1985). Much research exists to support the positive effects of both supplanted and generative strategies, but when compared one to the other, while research results are mixed, often generative strategies show more learning gain.

In an attempt to understand and explain the mixed results, we hypothesized that the selection of a specific generative or supplanted strategy which links to-be-learned information to existing cognitive structure should be determined by the cognitive processing abilities of the learners. Learning strategies were examined for cognitive processing requirements and then matched with cognitive strengths of the learner based on various cognitive styles.

This research should influence the development of new models for computer based instruction from a number of perspectives. First of all, it frees us from a solely tutorial based model of CBI and provides much support for newly developed computerized "learning tools" such as Kozma (1989) has developed. These "learning tools" facilitate the manipulation of information by removing the hassles of manual erasing/redrawing. The second is from the perspective that the computer can be programmed to diagnose styles and automatically branch to a learning or instructional approach that matches the cognitive strengths of the learner. The question we attempt to answer in this presentation is whether these learning tools which provide opportunities for facilitated generative learning are appropriate for all learners, or whether there are strategies that would be best presented in a supplanted, instructional manner for specific individuals.

A decision matrix for selecting supplanted vs generative strategies will be presented and elaborated upon using analytic and global, and serialistic and holistic cognitive styles matched with two learning strategies of main ideas and concept maps. Results of a pilot study which used a computerized tool examining these hypothesized relationships will be presented.

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THE MODEL OF A PEDAGOGUE IN A COMPUTER-AIDED ELEMENTARY SCHOOL SCIENCE LESSON

Kathleen McDermott Hannafin and James E. Gall, Florida State University

The need for courseware authors to attend to the issues of pedagogy has long been debated (Hannafin & Mitzel, 1990; Merrill, 1985; Zajonc, 1984; Roblyer, 1981). While pedagogy can play a critical role in learning new information, it is a costly lesson requirement and is thus often neglected in the courseware development process. The microcomputer-based pedagogue presented here is a demonstration of a cost-effective and pedagogically efficient model.

This computer-based pedagogue is an embedded lesson feature designed to actively engage the student in lesson content by employing an inquiry style of teaching. This model uses cognitive instructional techniques to guide student interest via a series of activities ranging from information gathering through hypothesis testing. The lesson content focuses on elementary school science for grades 3 through 5, presented in a student-centered exploratory science lesson.

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THE DESIGN AND DEVELOPMENT OF A COMPUTER-BASED LEARNING SKILLS PROGRAM: AN EXAMPLE OF INSTRUCTIONAL AND MOTIVATIONAL DESIGN MODELS IN ACTION

Atsusi Hirumi, Florida State University

The purpose of this presentation is to describe the application of both instructional and motivational design models in the development of a computer-based learning skills program. The objectives are to provide instructional designers and courseware developers with: 1) a systematic method of applying instructional and motivational theory during the design and development of computer-based instruction; and 2) examples of how instructional and motivational strategies may be applied in the development of learning skills courseware. A theoretical foundation for integrating instructional and motivational strategies during the preparation of computer-based instruction is also discussed.

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TOWARDS A MULTIFACETED THEORETICAL FRAMEWORK FOR COMPUTER-ENHANCED LEARNING ENVIRONMENTS

Michael J. Jacobson and Jihn-Chang Jehng, University of Illinois at Urbana-Champaign

While there has been a dynamic growth in the utilization of instructional computing technologies over the past quarter of a century, the articulation of the theoretical basis of these technologies in the fields of education and training has been more problematic. This presentation suggests that--in the near future at least--no single theoretical paradigm will be capable of guiding the development of instructional computing systems for the wide range of learning situations that exist. Instead, a *multifaceted theoretical framework* is being proposed to deal with a *pluralistic* theoretical universe.

This framework allow the analysis of selected cognitive theories of learning which have particular relevance to the development of different types of computer-enhanced learning environments. In particular, the framework focuses on two critical elements associated with the overall learning context: (a) *conceptual characteristics* of the domain being learned (i.e., the *complexity* of the concepts and tasks and the degree of hierarchical *structure* within the domain), and (b) the learner's *stage of learning* (i.e., novice or advanced). The multifaceted theoretical framework is intended to offer a meta-level perspective for analyzing the complex interaction of cognitive theoretical constructs, contextual elements associated with learning, and characteristics of different types of computer-enhanced learning environments. It is hoped that such a framework could provide both analytical and practical guidance for applying the most current cognitive instructional theories and research to the increasingly sophisticated arsenal of emerging technology systems.

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ERIC: WHAT IS IT AND HOW TO USE IT

Jane Klausmeir Janis, ERIC Clearinghouse on Information Resources

The Educational Resources Information Center provides access to a wealth of information in the field of education. This presentation will cover what is available and an overview of the different access points to the information.

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THE EFFECTS OF AUDIO IN CBI ON READING

William E. Johnson and Gregory C. Sales, University of Minnesota

Audio, particularly speech, is becoming a common feature of computer-based instruction. Yet, little research on the effectiveness of this feature has been conducted. This presentation examines results of a research project which investigated the effects of audio and speech features in a popular commercial phonics and vocabulary product.

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CONVEYING STRUCTURAL KNOWLEDGE IN HYPERTEXT KNOWLEDGE BASES

David H. Jonassen and Sherwood Wang, University of Colorado

One of most often cited putative advantages of hypertext is that it can mimic the associative properties of human memory. That is, the nodes and links in a hypertext knowledge base are able to map the active structural networks (Quillian, 1968) or semantic networks that describe the constructions of human memory. The implicit hypothesis of this advantage is that knowledge structured hypertext will map more readily onto users' knowledge structures.

Another way of conceptualizing these semantic properties of memory and hypertext knowledge bases is structural knowledge. Structural knowledge is the understanding of the interrelationships between ideas in memory. It is a form of conceptual knowledge that mediates the gap between declarative and procedural knowledge. Declarative knowledge represents awareness of ideas, while procedural knowledge represents application of that knowledge. Procedural knowledge, however, is predicated upon structural knowledge in order to fulfill the functional relationships between ideas.

If hypertext is better able to represent structural knowledge in its knowledge base, the issue is how best to convey that structure in the user interface. Jonassen (1990) described a variety of tools for eliciting structural knowledge from experts in order to map onto hypertext structures. These techniques explicitly map ideas and their structural relationships. These techniques were used in this study to map the structure of knowledge onto a hypertext knowledge base about hypertext.

Methods

Instruments. In order to assess structural knowledge acquisition, learners completed a word association task prior to treatment consisting of free word associations to key concepts related to hypertext. Free word association is the benchmark method for assessing cognitive structure (Preece, 1976). Following treatment, learners once again completed the same task. ollowing the free word association, learners were administered a multiple choice test which paraphrased the nature of the relationships between sixteen key terms related to hypertext. These are accepted tests of structural knowledge. Additionally, learners completed recall tests of information contained in the knowledge base.

Treatments. Three treatments were developed for this study from the HyperCard version (Jonassen, Roebuck & Wang, 1990) of the book *Hypertext/ Hypermedia* (Jonassen, 1989). The hypertext was a browsing system consisting of 240 card in three stacks with bookmarking and limited annotation capabilities. Treatment 1 consisted of embedded referential links between cards. Terms in the text were highlighted, enabling learners to traverse the links. Treatment 2 consisted of the same capabilities with the added feature of a pop-up window mediating each link. Text in the window stated the explicit relationship between the node the learner was leaving and the node the learner was going to. Treatment 3 consisted of the same card with no embedded links. Instead, in order to navigate, learners had to access a graphical browser, which visually mapped the node and all of the possible links to it. Overview maps showed all of the nodes in a section of the hypertext.

Procedure. Preservice teachers in a teacher education program were given the task of learning about an important new instructional technology, hypertext, as an assignment in a pre-service instructional technology course by using a hypertext. This was a required assignment in their course. In a Macintosh laboratory, students individually interacted with the hypertext in order to acquire as much information about this new technology as possible. A monitoring program was added to the stacks to audit the action and the time allotted to each learner action. Following the interaction, learners were asked to complete the posttests.

Results

Data are being collected in June and September of 1990. It is anticipated that learners in the graphical browser group will exhibit the highest level of structural knowledge. That is, they will generate the greatest number of associations. It is anticipated that learners in the pop-up link explanation version will perform better than the referential link version on the multiple choice test. Multivariate analysis of variance will be used to analyze difference between group performances. Audits of learners' navigations will be entered into transformation matrices which will be analyzed using cluster analyses.

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COMPUTER-BASED INSTRUCTION IN THE DEVELOPING COUNTRIES: A RESEARCH-BASED MODEL FOR DEVELOPMENT AND IMPLEMENTATION

Marshall G. Jones, Steven W. Harmon, Thomas C. Reeves, University of Georgia

This study reports on the status of CBI in 10 developing countries. The findings are based on interviews with national educational leaders plus interviews with US consultants. The findings form the basis for a CBI development and implementation model in developing countries including: strategies for dealing with cultural sensitivity, technological appropriateness, and conviviality. The roles of donor organizations and international consultants are also critically examined.

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PRESCRIPTIVE STRATEGY ANALYSIS: PROGRESS REPORT OF THE SECOND GENERATION ID RESEARCH PROGRAM

Mark K. Jones and M. David Merrill, Utah State University

The overall goal of the Second Generation Instructional Design Research Program is to develop a comprehensive new generation of instructional design theory and methodology, and to build a set of intelligent tools that aid the designer in applying the theory. In the present project, Prescriptive Strategy Analysis, the researchers are developing the theory and methodology for automated prescription of instructional strategies, and will implement a prototype Strategy Analysis Component (SAC) intelligent tool to carry out this function.

SAC performs the following functions:

- gather generally applicable information about the audience and the resources and constraints of the setting, and storing this in strategy knowledge base;
- recommend instructional transactions to instruct content identified by the knowledge analysis;
- direct and constrain further knowledge acquisition based on recommended transactions;
- prioritize authoring of transactions.

The session will overview the goals and design of the project, and discuss the impact of this approach upon the instructional development process.

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COMPUTER-BASED INTERACTIVE VIDEO: POTENTIALS AND LESSONS FROM PAST RESEARCH

Karen Lee Jost, Syracuse University

Past media research tried to show that the medium itself made a difference. Research in instructional technology needs to be directed, not at the medium, but at such things as instructional methods, the settings in which instruction takes place, the cognitive processes engaged through the use of symbol systems, the effect of how content is structured, and the use of learning strategies. It is also important to explain how individual differences affect how learners process and carry out instructional activities and to investigate the impact that various kinds of interactions can have on different learners. Refined questions focusing on specific salient attributes and qualities of a medium, such as the depiction of movement, also furnish us with important information which can be applied to the design of effective instruction.

Computer-based interactive video is a complex combination of technologies. In order to fully understand its attributes, capabilities, and potentials we need to look at its many component parts. From an educational standpoint, we are not only interested in how they have been typically used, but in what they can potentially be made to do. The purpose of this presentation is to analyze the interactions between learner characteristics and instructional features. It will address the unique capabilities and potentials of CBIV. The presentation will also discuss important lessons from research on other media and on specific salient media attributes that we can build on in understanding how these features affect the learners' cognitive processes when interacting with CBIV. Included will be a discussion of the effects of such instructional features as learner control, learning strategies, and motivational variables.

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INTELLIGENT TOOLS FOR INSTRUCTIONAL DESIGN

Zhongmin Li and Mark K. Jones, Utah State University

The goal of the Second Generation Instructional Design Research Program is to develop a new generation of instructional design theory, and to build intelligent tools to aid designers applying the theory. This roundtable will discuss some of the issues raised by research into developing intelligent tools for instructional design, such as their feasibility, the utility of techniques developed for experts systems construction, and the value of tool building as an adjunct to theory development.

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KNOWLEDGE ACQUISITION AND ANALYSIS: PROGRESS REPORT OF THE SECOND GENERATION ID RESEARCH PROGRAM

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The goal of the Second Generation Instructional Design Research Program is to develop a new generation of instructional design theory, and to build intelligent tools to aid designers applying the theory. In the present project, the researchers develop a theory for acquiring, analyzing, and representing subject matter knowledge for instructional design and delivery, and develop an intelligent tool to perform this function. This session overviews the goals and design of the project, and demonstrate the system.

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FEEDBACK INDUCED COGNITIVE DISSONANCE AND ITS EFFECT ON LEARNING AND RETENTION

Joseph A. Marrone and Kyle L. Peck, Pennsylvania State University

Although algorithms exist to allow computers to evaluate open-ended answers during CAI, this evaluation is far from perfect. However, attempts to make computers better evaluators may be misguided. By asking computers to evaluate answers we may be eliminating a powerful tool in the learning process.

This study investigated the benefit of asking students to validate the computer's imperfect evaluation of their answers, speculating that the cognitive activity involved in examining and contrasting the preferred answer and the one considered incorrect may enhance learning and retention.

Following video-based instruction, one hundred and seven university students took a test consisting of 24 open-ended items. Half of the questions employed intentionally inferior answer analysis, increasing the probability that potentially correct answers would be considered incorrect. After answering all 24 items, each item was reviewed with the student and students were allowed to agree or disagree with the computer's assessment and, in one treatment, to provide a written explanation of why their answer was correct. The dissonance and subsequent processing caused when the computer incorrectly evaluated a correct response as incorrect led to significantly greater retention as measured on an identical test administered one week later.

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ESTABLISHING AND MAINTAINING A PROFESSIONAL KNOWLEDGE BASE THROUGH EXTENDED COMPUTER-MANAGED PRACTICE

Kyle L. Peck, Pennsylvania State University

Salisbury (in Jonassen, 1990) provided recommendations for CAI drill designers based on cognitive learning theory: automaticity; interference; spaced practice; spaced review; and capacity of short term memory. A computer-managed practice system based on these principles was demonstrated.

Practice items move through six "states," from "new" through "rehearsal," "drill," and three reviews. After successful completion of an item it advances to the next state, is removed from the "working pool" of items and is "date stamped" for retrieval during a subsequent session. The duration of delays between sessions may be set by the student (or researcher) as may the number of items in the working pool, which determines the size of the subset of items presented concurrently, limiting interference and accounting for limitations of short term memory.

This system, based the "progressive state" model proposed by Atkinson (1974), is capable of presenting activities of any type, including complex labeling activities and simulations.

Research examining the size of the working pool reveals that although there are no significant differences in achievement when the working pool is increased from 7 to 14 items, students voluntarily using the lessons on their own time remained engaged in the activity longer when working with a 14 item working pool.

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INSTRUCTIONAL THEORY INTO PRACTICE: INSTRUCTIONAL MODELS

Franklin C. Roberts, Western Washington University; Peter J. Rizza, Princeton Center for Education Services; Thomas Reeves, University of Georgia; and Lynn Misselt, Authorware, Inc.

Designing effective instruction is a difficult, labor intensive activity. Despite elaborate training and new software tools, we often reinvent the wheel when we design instruction. We fail to capitalize on our experience, and we often ignore the commonality that exists across many training and instruction tasks. One way of overcoming this is through the design and use of instructional models. This notion of instructional models provides a potentially powerful avenue by which effective instructional materials can be developed more quickly and more easily than by traditional methods.

This panel session brings together people working on four different projects in instructional modeling. The first uses models in a graduate program in instructional technology. In a course on CBI, a model has been designed which provides a generalized approach to the design of tutorial and drill lessons. This model focuses the students' attention on manipulating a set of micro-strategies that reflect principles of instructional design and screen management.

The second project used instructional models in the development of a large curriculum project. This project required the development of numerous CBI lessons in an academic curriculum. A small library of models were developed that reflected common strategies that were found across the curriculum. This models-based approach was used to make the design task easier, and to ensure that the final lessons were both consistent and pedagogically sound.

The third project is an effort to develop a set of models for use within an authoring system, Authorware Professional. This has resulted in a library of model-based productivity aids. The models are an application within the authoring system, so that the user can rapidly build lessons by organizing a set of pre-existing model components. The lessons can be modified to reflect different strategies or content. The facility is also available for users to build their own set of models.

The final project considers models in instructional technology research. One of the perennial problems in social science research is the lack of replicability. In instructional technology research, studies are often conducted over extremely short periods of time, or with unvalidated materials, or with fictitious content. This project proposes the development of a set of standardized lessons across a range of curricula. The project would develop and validate a set of instructional models, and then implement them across several content areas. Researchers could then manipulate various components in the materials, allowing greater strength in their conclusions and in the generalizability of the results.

KNOWLEDGE ACQUISITION SYSTEMS BASED UPON STRUCTURED COMMUNICATIONS AND PATTERN NOTING TECHNOLOGIES

Alexander Romiszowski and Charles R. Dills, Syracuse University

Structured Communication and Pattern Noting are both educational tools that have recently become popular. Some experiments exploring their development as knowledge acquisition tools, both independently and as an integrated system, are described, and ways in which they can be used to acquire deep-structure knowledge are described.

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ENHANCING PERFORMANCE THROUGH HUMAN AND AUTOMATED COACHING

Allison Rossett, San Diego State University

What makes an effective human or automated coach? What lessons do sports and music coaches have for us? What do the differences between off-line and on-line coaching opportunities mean to someone who is designing a course, supporting a colleague or developing computer-based training? This presentation will use research, theory, and lively examples to coach the audience on coaching.

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COMPUTER ANXIETY: OVERVIEW

Mioko Saito, University of Oklahoma

Computer-based instruction CBI has been introduced to schools to provide more effective and efficient earn:n. As of 1990, there are over 20,000 educational software titles available on the market; virtually every subject matter n school curricula for every grade level has been developed into courseware (Computers/Associates, 1990).

However. no matter how good the courseware may be, the effect of using educational software has been inconclusive. One reason or this may be the difference in learners' attitudes toward using computers. As Bloom (1976) contends, learning in the affective domain can influence the cognitive learning outcome, and motivation is the key to influence learning. The implication of Bloom in computer education is that only those who are motivated and have positive attitudes toward computer may learn from computer-based instructions. Those who have negative attitudes toward computers may not get the benefit of the effective courseware.

Addressing the affective factor, therefore, is important in order to have the successful curriculum using computers. This presentation will review the current research in computer anxiety in relation to math anxiety, test anxiety, and Spielburger's (1966) trait and state anxiety. It also will address the suggestions for incorporating computer curriculum in schools in terms of instructional design and environmental design aspects.

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THE EFFECTS OF ADVISEMENT ON ACHIEVEMENT IN LEARNER-CONTROLLED INSTRUCTION

Rowena S. Santiago and James R. Okey, The University of Georgia

The effectiveness of learner control in computer-based instruction has not been optimized due to learners' difficulties in making good decisions. Therefore, learner control with advisement has been recommended for CBI. But which type of advisement will work for which type of learners remains a problem to instructional designers.

This paper investigated three types of advisement (adaptive, evaluative, combined) used in CBI with learner control conditions and their effects when used among learners of varying locus of control (internal, middle, external). A randomized, posttest only design was used. Subjects (N=74) worked on a CBI module dealing with Gagné's events of instruction and received advisement in the practice phase of the lesson. The dependent variable was posttest performance.

Main treatment effects and interaction were tested using a two-way ANOVA. When non-significant interaction and significant main effects were found, mean scores were compared using Fisher's PLSD. Results showed significant differences among both the advisement treatments and the LOC groups. Adaptive advisement resulted in better performance and internals did better than externals on the posttest. Adaptive group students were also found to follow advisement more frequently and chose to do more practice than those in the other two groups. Internals and externals chose to do similar amounts of practice but externals followed advisement more frequently than internals.

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CAI MENUS AS LESSON STRUCTURING DEVICES

Robert L. Schuerman and Kyle L. Peck, Pennsylvania State University

There are numerous guidelines for the proper design of menu systems in educational software, but there is little empirical evidence to support these guidelines. A better understanding of the role of a menu system as an implicit lesson-structuring device in learner control CAI environments would allow designers to anticipate the learner's dominant selection patterns and optimize the menu structure accordingly.

A learner-centered CAI lesson on the classification of questions according to "Bloom's Taxonomy" provided 100 undergraduate subjects with 15 independent learning activities selected from three pull-down menus, available across the menu bar on an Apple Macintosh computer. The study investigated the effects of 1) sequentially numbering the menu options, 2) "checking off" completed menu entries, and 3) a typical, unenhanced (control) condition on the subjects' selection patterns.

Analyses designed to assess the sequentiality of selections (within and across menus), tendencies to complete entire menus before moving to the next menu, tendencies to re-enter completed activities, and the degree of deliberation during menu selections revealed no significant differences. Subjects, regardless of treatment, tended to proceed through menus in a sequential manner.

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THE INFLUENCE OF GRADE MOTIVATION IN A HYPERMEDIA LEARNING ENVIRONMENT

Tom Sextro, John B. Brungardt, and Jack Byars

The purpose of this study was to determine the influence of grade motivation on students in a hypermedia learning environment. Dependent variables were persistence, as measured by the number of options chosen in learner controlled structured hypermedia lessons, and posttest achievement. The results indicated that high grade motivation subjects chose significantly more options than did low grade motivation subjects ($p<.01$). No significant difference of grade motivation on achievement was noted. Repeated measures testing resulted in a significant interaction effect of lesson experience on the number of options chosen for each of two lessons ($p<.05$). High grade motivated students chose less options on the second lesson, whereas low grade motivated students chose more options on the second lesson.

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WAIT TIME AND GUIDANCE IN INTERACTIVE VIDEODISC INSTRUCTION

Eric E. Smith, University of Northern Colorado

A series of 5 studies investigating the effects of forced pauses, guidance, and learner control during the presentation of tutorial information have been conducted. The goal of the research is to begin developing a model of instructional variables that can be controlled by the designers/developers of CBT to enhance the effectiveness of the instruction.

While not conclusive, the results indicate that the use of forced pauses may benefit learners when strategically placed after information has been presented and before any review questions or summaries. The use of guided processing during those pauses is also supported. However, the results indicate that the guided processing used was not effective when subjects controlled the pace of guidance screens and the score on the post test was of minimal value.

The design was essentially the same across all studies, with the exception of the number of treatments in a particular study. The same program was used for all treatments, except for the changes in the specific variables investigated.

This presentation will cover the theoretical basis for the studies, the specific results of each study, and the implications for the design and development of interactive videodisc instructional systems.

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DESIGN-BY-ANALOGY: AN ALTERNATIVE APPROACH

Steven D. Tripp, University of Kansas

In his book, **Designing Instructional Systems**, Romiszowski cites Polya's approach to problem solving as a scientific model for instructional design. Among other things, Polya's method involves the analogical process of searching for existent solutions to similar problems. Although Romiszowski mentions this as a possible design methodology, he does not work it out in any detail. Romiszowski's model, like all standard ISD models, assumes that instructional designers start from scratch for each project.

The purpose of this paper is first to work out in detail the implications of the Polya model of problem solving, second to review literature on analogical reasoning, and then to propose an alternative model of instructional design based on the use of analogical reasoning. Justification of the model will be based upon research on the nature of analogical thought and an examination of analogous design models from other fields.

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THE EFFECTS OF VERBAL AND VISUAL METAPHORS ON LEARNING FROM A HYPERTEXT BILINGUAL DICTIONARY

Steven Tripp and Warren Roby, University of Kansas

This study is an extension of one presented last year. For this study students were presented with a 120-word Japanese-English hypertext dictionary and given 15 minutes to learn as many Japanese words as possible. The dictionary consisted of 24 semantic clusters of five words each. All subjects received a HyperCard stack with identical links and buttons. However, the amount of information available to students was varied between groups. Two crossed between-subjects factors were investigated. The first was the presence or absence of a verbal metaphor which served as a kind of advance organizer. The second was the presence or absence of a visual metaphor. Dependent measures were recognition and recall of vocabulary. We hypothesized that a lack of information about the semantic hyperspace would cause disorientation which would in turn draw upon limited mental resources, reducing learning. In the previous study, verbal and visual information did not have an additive effect on retention. We speculated that the advance organizer, which was written in literal terms, and the metaphorical graphics induced conflicting mental models which reduced achievement. The present experiment is an attempt to test that hypothesis by presenting congruent verbal and visual information.

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A HOLISTIC MODEL FOR INTERACTIVE INSTRUCTIONAL EVALUATION: THEORY AND TWO CASES

Susan A. Tucker and John V. Dempsey, University of South Alabama

This presentation focuses on designing and implementing effective interactive instructional evaluation (IIE). IIE is the systematic study of an interactive problem or innovation in order to make effective decisions or recommendations about future actions. Specifically, the presentation has three goals. The first goal is to analyze briefly the strengths and weaknesses of prevailing evaluation models (e.g., objectives-oriented, consumer-oriented and management-oriented) in order to provide a grounding context. Second, the IIE model will be presented which addresses 13 major theoretical and practical issues faced by professionals working with interactive instruction. Assuming evaluation is only as good as the shared reality that the evaluator is able to coalesce across significant players, the authors suggest 13 critical polemics which capture overt and hidden agendas but do not limit our capability to describe and judge program elements. Using a negotiation process to reveal these perceptions, operative values can be embodied in the major questions which focus the evaluation paradigm. In addition, these values can serve as judgment criteria for decision-making. A final purpose is to describe specific steps, tools and techniques of IIE to compatibly complement the design, development and delivery of technologically mediated interactive instruction. Examples will be drawn from IIE evaluations applied to two medical education projects, one short-term and the other operating over a three year cycle.

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A COMPARISON OF TWO CONTENT SEQUENCING THEORIES APPLIED TO HYPERTEXT-BASED INSTRUCTION

Kathleen Kemps Wagner, University of Northern Colorado

This presentation discusses the application of Elaboration Theory and Structural Learning Theory to hypertext/hypermedia instructional systems. The subjects will be employees of a large electronics manufacturing firm in Colorado. Results of a study comparing learner performance following instructional treatments that differ only in the theoretical approach for sequencing the material will be discussed and implications for the design of hypertext/hypermedia materials presented. This study will be conducted in September and October 1990. While both Elaboration Theory and Structural Learning Theory have been around since the 1970's, little empirical evidence to support either theory exists. In addition, both theories suggest sequencing structures for material that have analogs in the structure of hypertext documents. The Elaboration Theory analog is a node-linked structure while the Structural Learning Theory analog is a hierarchical structure. This study is a first step in the investigation of the application of instructional design models to hypertext presentation/instruction systems and, to a limited degree, a validation study of the models selected. This presentation reviews the theories, their application via hypertext (including completed courseware) and the results to date.

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THE PRESENTATION AND ORGANIZATION OF MENU ITEMS ACCORDING TO NOVICE AND EXPERT USERS' NEEDS

Linda M. Wang, University of Georgia

This presentation discusses two components, the representation and organization of menu information, and menu accessibility for manipulating the interactive computer interface with regard to novice and expert users' needs. Guidelines for representing the menu information more effectively through the appropriate interface style will be discussed, along with the organization of the menu information in relation to the use of menu selection systems.

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COOPERATIVE LEARNING, INTERACTIVITY, AND YOUNG ADULTS: EVALUATING STRATEGIES FOR STUDENTS COLLEGE AGE AND OLDER

William H. Wheeler, Jr., The University of Georgia; and Linda M. Conn, Valdosta State College

Although students may benefit from "individualized" instruction, for many, individualized instruction presented via **a computer** may actually be synonymous with "isolated" instruction. There may be a number of benefits for learners from well-designed cooperative learning programs, including aiding cognitive processing, relying on each other for additional help, and positive affective outcomes . Although many cooperative learning programs have been implemented, these have usually involved younger learners. Cooperative learning strategies have not generally been implemented and evaluated with students of college age and older.

This paper evaluates the effectiveness of CAST (Computer Assistance for Science Teachers), an interactive videodisc program running on an IBM InfoWindow platform which incorporates a cooperative learning strategy. CAST was developed at the University of Georgia under a grant from the National Science Foundation. Students completed the program, which includes tutorials, simulations, full-motion video, animation, and color graphics, in groups of three. All of the participants in the study were college age or older. Quantitative and qualitative methods were employed. Qualitative and quantitative results will be presented, and implications for future research will be discussed.

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AN INFORMAL MODEL OF THE HUMAN-COMPUTER INTERFACE: PROCESS, ERRORS, AND INTERACTION

William H. Wheeler, Jr. and Hueyching Janice Jih, The University of Georgia

Advances in the computer tools available to instructional technologists and courseware designers have generated a need to integrate knowledge from human factors analysis, user interface design, and instructional design. Easily learned authoring systems with powerful interface design controls place the complete range of user interface design decisions in the hands of courseware designers whose professional training may **not** include the discipline of human factors analysis and its influence on user interface design. Direct control over screen design, text design, graphics display, menu options,and branching exerts a profound influence over the **learning context** and such measurable **human factors** as: time to learn, speed of performance, user error rate, subjective satisfaction, and retention (Shneiderman, 1987).

Objectives of the paper include: (1) providing courseware designers with guidance and a framework for decisions where knowledge of human factors could be influential; and (2) identifying areas of research that would integrate knowledge from human factors analysis and instructional courseware design. We will present a model of the human-computer interaction system. The model offers a structure for the examination of a variety of context variables and error sources originating in four phases of human/system interaction: (1) computer presentation; (2) user response; (3) computer checking; and (4) computer feedback.

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Selected Abstracts for the

Special Interest Group for Telecommunications (SIGTELE)

EDUCATIONAL TELECOMMUNICATIONS AND THE CHICKEN AND EGG PROBLEM

Bernie Dodge, San Diego State University

With many education-oriented BBS's and commercial networks becoming available to teachers and trainers, it is important to identify the critical attributes which make such systems succeed or fail. A computer model has been developed based on analysis of teachers' use of the FrEdMail network and CSUNet systems in California. The model, written in HyperCard, will be used during the presentation to demonstrate various strategies for building a critical mass of users. In the model, the central variable is the probability of a user calling the system again, which is primarily a function of the cost of accessing the system, the ease of use, and the perceived usefulness of the system. The latter variable, in turn, depends on the amount of information on the system provided by other users, and information provided by the system operators. The model suggests strategies for increasing use of a telecommunications system to get beyond the chicken-and-egg problem and achieve a critical mass of the desired type of user. The principles underlying the model may be applied to any telecommunications medium which depends at least partly on user-supplied information and dialog.

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TELECOMMUNICATIONS FOR TRAINING: A TUTORIAL

Thomas Downey, Boeing Commercial Airplane Group

Training at a distance in both asynchronous and synchronous modes will be addressed. What type of equipment to use and how it works will also be featured.

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NEW PATHWAYS TO A DEGREE: USING TECHNOLOGIES TO OPEN THE COLLEGE

Stephen C. Ehrmann and Michael Strait, Annenberg/CPB Project

The Annenberg/CPB Project will announce the winning projects in its funding program, "New Pathways to a Degree: Using Technologies to Open the College."

Many learners, now part-time students or not enrolled, could work more readily toward a baccalaureate if colleges used technologies to offer more accessible, effective academic programs. Each New Pathways project will offer: a) courses and services that are highly accessible to working and homebound learners, and others; b) rich resources for learning, different from but comparable to opportunities traditionally available for full-time students on campus; c) opportunities for frequent conversation and exchange between students and faculty; and d) substantial and coherent opportunities to work toward a degree. The projects each use some combination of available information and telecommunications technologies. This session will analyze the submitted proposals, and spotlight several of the New Pathways projects.

Analysis of Proposals: Well over 10% of all colleges and universities in this country participated in a New Pathways proposal. Michael Strait will present an analysis of what these proposals signal about which colleges are interested in using technologies to extend their programs, and how they are planning to do it.

Discussion by Project Directors: The remainder of the panel will begin with a brief description of the winning projects, and a discussion of how the Annenberg/CPB Project hopes to continue to work with all applicants and others interested in these issues. The discussion will then shift to three of the funded projects represented on the panel. After summarizing their basic strategies, the three project representatives will address several generic questions, including: a) the toughest problems each program will face as they begin their work, and b) institutional and national policy questions that are raised by these new, more open kinds of academic programs.

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AN EXPLORATION OF SOCIAL AND INTELLECTUAL "CONNECTEDNESS" THROUGH ELECTRONIC MAIL IN HIGHER EDUCATION

Barbara L.Grabowski, Syracuse University; and R. Scott Grabinger, University of Colorado at Denver

The use of electronic communications is increasing in our society today. The purpose of most of the reported uses is to reduce problems caused by large geographical distances between colleagues. However, some very important effects from local uses of electronic mail can also be realized. Kuehn (1988) suggests that electronic mail can extend classroom discussions, increase "connectedness" of students and faculty, and increase the timeliness of those interactions.

Given that a college community should foster frequent intellectual and social exchanges among the students, Kuehn's suggestions have great appeal. At two very diverse universities, one in the east, one in the west, one an undergraduate and the other a graduate community, we conducted a survey to assess the social and intellectual "connectedness" of their students. The purpose was to answer four questions: 1) Who is most likely to use electronic mail?; 2)For what purposes are users communicating via electronic mail?; 3) What factors influence positive perceptions and level of use?; and 4) What are the student's perceptions of the social and intellectual impact of electronic mail? Demographics, purpose, and frequency of use data were collected to satisfy the first three questions. Using a Likert scale, we tested student's perceptions of electronic mail use. While details of the results will be presented and compared between institutions, there were some interesting overall results. Analysis of the demographics showed differences in perception between gender, with females being significantly more positive than males. In addition, those who used electronic mail for exchanging social information, initiating friendships, and alleviating boredom also had a significantly more positive perception of electronic mail in general than those who did not use email for those purposes.

Reference

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COMPUTER MEDIATED COMMUNICATION: A HYPERTEXT APPROACH TO STRUCTURING DISTANCE SEMINARS

Alexander Romiszowski, Karen Jost, and E-Cheol Chang, Syracuse University

Several approaches to the construction of content-organizational tools that assist participants in maintaining a structured view of a computer-mediated seminar over time are described. An experimental hypertext environment has been used in several different ways, resulting in varying degrees of effectiveness. This paper presents and discusses the results of several experiments.

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WILL THE CAMPUS OF THE FUTURE HAVE A CAMPUS? THE IMPACT OF TELECOMMUNICATIONS ON RESTRUCTURING EDUCATION AND TRAINING

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This presentation will do two things: 1) inform participants about trends in higher education, workforce development, the information explosion and telecommunications, and their effects on restructuring higher education; and 2) demonstrate an effective, alternative educational model that incorporates telecommunications technology. Telecommunications offers the possibility of thinking about different ways of providing instruction and training in a cost effective way. In its twenty-year history, SUNY/Empire State College has developed a highly successful, distributed, off-campus program serving 10,000 adults per year. We are now integrating telecommunications technology into our academic program. We believe the success of our educational model for serving adults has implications for restructuring higher education and training. While institutions and organizations may not adopt the complete ESC model, our experience offers valuable ideas for rethinking the structures of higher education and training. Participants will learn: why the campus of the future may not have a campus; how Empire State College's off-campus program can provide a model for restructuring higher education; how telecommunications technology can enhance off-campus learning and assist in overcoming its limitations; and, what issues need to be considered as telecommunications usage grows in higher education.

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A COST EFFECTIVE ALTERNATIVE TO VIDEO TELECONFERENCING

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This presentation describes a cost effective distance education course utilizing Macintosh microcomputers, HyperCard displays, a conference telephone, and a modem for two-way communications. A graduate statistics course was delivered simultaneously at two sites 100 miles apart. The conference telephone carried the professor's lecture and allowed students at both sites to communicate with the professor and each other. HyperCard stacks supported the lecture.

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Selected Formal Papers from the

Special Interest Group for Academic Computing (SIGAC)

NETWORK TECHNOLOGY: ITS IMPLICATIONS TOWARD EDUCATION AND ITS IMPLEMENTATION

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Abstract

With networking technology being applied to all levels of education, the question becomes one of what pedagogical implications does this technology have toward education? Does it simply provide a means of communication, or does it have broader implications? This paper will assess these questions and describe the implementation of networking technology at Lehigh University.

Educational Implications

The typical user of networking technology simply wants easy access to computing resources. As Redlawsk (1988) pointed out: "At its simplest level, connectivity means access." (p.358). Networking technology involves more than simply connecting computers together for simple data manipulation. Schamber (1988) described an information network as having the characteristics of widespread coverage, a wide variety of services, distributed control, security, multimedia capability, integrated software, adaptability and expandability, and reliability. So, with networking technology including everything from local area networks (LAN's) and digital switches to backbone networks with high-speed data, audio, and video capabilities, what are the implications of this technology toward education?

Connectivity

Educational implications of networking technology with respect to connectivity are dependent upon the level of networking technology being implemented. Levels to be discussed here include local area networks (LAN's), campus-wide networks, and national or international networks.

In educational settings, local area networks are typically found in microcomputer classrooms. LAN's consist of individual microcomputers which are interconnected, typically via a printed circuit board plugged into each microcomputer, and wiring connected to the circuit boards. An integral part of a LAN is the LAN file server which is a microcomputer dedicated to running the LAN and which contains all of the software for the microcomputers on the LAN. As for educational implications of LAN's, Thrush and Hardisty (1989) state that computer networks [LAN's] may provide for interaction between a user and knowledge contained on the network, between the user and other users, and, through word processing, between the user and the text.

Campus-wide networks are typically either backbone networks or digital switches (i.e., a digital phone system). These types of networks have similar general capabilities, but the backbone network is capable of much higher data transmission rates and can interconnect other networks, such as LAN's. As Redlawsk (1988) points out, most users of these types of networks just want to get from point "A" to point "B", connecting one computer or terminal to another computer, with a minimum amount of effort. The educational implications of this type of network are dependent upon the distributed accessibility of computing resources. For example, the user can connect to the library computer and any number of academic computers, all from one location.

Campus-wide networks, especially backbone networks, are often connected to external networks. These external networks may be national or even international in scope. Two of the larger of these networks are CREN (Corporation for Research and Educational Networking, formerly BITNET), and the Internet. Dyrenfurth (1986) describes the capabilities of BITNET as including users sharing information via real-time terminal messages and electronic mail, transfer of documents and files, and access to data services. The Internet is really a collection of interconnected networks which provides the same basic services as CREN, but at higher speeds and with the ability to actually log in and utilize remote computer resources (assuming one has an account or permission to do so). The educational implications of these external networks range from simply communicating electronically with a colleague at another location, to having access to databases and information located elsewhere in the world, to having high-speed access to computer resources located external to one's own institution.

Pedagogical Implications

The pedagogical implications of networking technology can span every subject area. Thrush and Hardisty (1989) described how networking technology can be used to teach language learning skills. The researchers believed that students can develop the ability to communicate interactively with information sources, with other students, with experts, and with text stored as word processing files. Utilizing LAN's, students can acquire experience manipulating provided text while practicing editing procedures, and sharing text for peer editing and collaborative work.

In addition, Thrush and Hardisty elaborated how students can gain experience creating text via "the progressive story" and "the paper cycle" techniques. The progressive story involves small groups of students finishing several paragraphs which are started with dictated first sentences. After members of each group check the literary characteristics of the resulting stories (grammar, organization, vocabulary, and creativity), hardcopies of the finished stories can be distributed to the entire class. The paper cycle is a procedure students and teachers follow to progress from the brainstorming of ideas to the final draft of a paper. Lastly, Thrush and Hardisty suggested conferencing within a structured activity to promote interactive communication among students who may otherwise feel too self-conscience to speak or share ideas in a traditional classroom environment.

Waugh, Miyake, Levin, and Cohen (1988) described how networking technology can be used to teach problem solving skills. In a particular problem solving project involving students from four different countries, solutions to a real-world problem were synthesized from students' research. Their descriptions of the problem and possible solutions were sent to all participating students via a network and then analyzed by all the groups of students. After acquiring additional needed research, students made decisions on the solutions they found to be most feasible for the problem in their respective locations.

Although a similar activity could be implemented in a more traditional classroom manner, the network technology provided a cooperative educational venture which included "a meeting place for like-minded teachers and students from all over the world" (p. 5). As stated by Thrush and Hardisty (1989), "development of network use is in its infancy, but even now, it provides some opportunities for the teacher and the learner that are almost impossible to achieve otherwise" (p. 4).

Communications

Whether it be a group of students utilizing a LAN to work together on a class project, or researchers collaborating at different institutions, the primary educational implications of networking technology relate to communications. This is not to imply that networking technology applies strictly to *electronic* communications. Studies such as that conducted by Daly, Weber, Vangelisti, Neel, and Maxwell (1987) show that networking technology can be used as an effective tool to not only explore how people communicate, but also to explore the thoughts people have as they communicate. By documenting the conversations individuals had over the networked microcomputers and the thoughts that were verbalized orally during the respective networked communications, the researchers observed three general thought processes taking place although not necessarily evident in the microcomputer conversation; inferencing, planning and coping with violations of conversation maxims.

Implementation at Lehigh

At Lehigh University, networking technology has been implemented in a number of different ways including local area networks (LAN's) within microcomputer labs, networks of workstations, a campus-wide digital phone system (digital switch), and a campus-wide, fiber optic-based backbone network. The backbone network provides connectivity between all of the other campus networks as well as national and international connections.

InteCom and the Network Server

At Lehigh, most people refer to the University's InteCom digital phone system as the "campus network." The InteCom system provides simultaneous voice and data communications to the university offices, labs, most classrooms, and most dormitory rooms. A menu-driven microcomputer-based program was developed at Lehigh to dial the phone and establish connections to Lehigh University Computing Center (LUCC) academic mainframe computers, to the on-line catalog system of the university library system, known as ASA (Automated System Access), as well as to other departmental and administrative computers.

One of the mainframe computers which can be accessed through the InteCom system is an IBM 4381, which has acquired the nickname of the "Network Server." The Network Server provides information and communications services to users of the InteCom system. On this system, course assignments can be submitted and returned via electronic mail. Course-oriented bulletin boards and conferences provide a level of interaction between faculty members and students which would not be present in non-networked environments; students who may hesitate to ask questions in class can ask questions electronically; faculty can post answers to questions, new assignments, and helpful class information. This system also allows for easy distribution of faculty written software as well as the filling out of on-line forms for requests for information or campus services.

Local Area Networks

Microcomputers at LUCC microcomputing sites are interconnected by means of local area networks (LAN's). In addition to the connection to the LAN, each microcomputer is also connected to the InteCom system through a serial port. This allows each microcomputer to dial and communicate with other computers such as mainframe computers. In addition to terminal emulation, this connection allows files to be uploaded and downloaded to and from the mainframe, respectively. One of the functions of the LAN is to provide software for this connection.

Educationally, these LAN's not only provide students broader exposure to software than would be available in a non-LANed environment, but also provide a medium for student/faculty interaction. Holding classes in a LANed classroom allows instant distribution of files and data, as well as instant electronic sharing of ideas.

The Backbone Network

In addition to the InteCom system and local area networks, Lehigh University is in the process of installing a TCP/IP-based (Transmission Control Protocol/Internet Protocol) backbone network between various campus buildings. The backbone network is a separate, high-speed network which links other networks. Currently, internal LUCC Ethernet networks (including LUCC staff LAN's) are connected to the backbone, as are some departmental LAN's within the connected buildings. It is anticipated that, eventually, all LUCC site LAN's will be interconnected by means of the backbone network.

The backbone network provides users of LAN's connected to it with the means to send and receive data at speeds far beyond those supported by the InteCom system. Since the backbone network is connected to the LUCC machine room Ethernet network, which in turn is connected to external networks, all users connected to the backbone are also provided access to the various services of the external networks.

Electronic Mail via CREN and the Internet

The University is connected to two different types of external networks; CREN (formerly BITNET, via the IBM 4381 "Network Server"), and the Internet (via all backbone network hosts). Gateways between CREN and the Internet provide users of one of these networks the ability to send electronic mail to users of the other of these networks.

At Lehigh, CREN is strictly for electronic mail. All users of the Network Server, as well as all users of LUCC's CYBER 850 and VAX 8530 mainframes (which are Internet nodes), can send to, or receive electronic mail from, all CREN and Internet users.

Internet Communications

The Internet provides services in addition to electronic mail by way of application programs such as TELNET and FTP (File Transfer Protocol). TELNET allows users to log in to remote computers from local computers, while FTP is for transferring files between computers that are connected to the Internet.

Since both the CYBER 850 and the VAX 8530 are connected to the Internet, FTP can be utilized as a quick and effective method for transferring files between these LUCC machines. In addition, TELNET can be utilized from either of these machines in order to access the other without logging out of the first machine. This can be an effective tool in the development of projects which require the use of both the CYBER 850 and the VAX 8530. The ASA on-line catalog system can also be accessed from either of these machines through TELNET, as can machines external to the University. External connections allow collaboration between researchers at Lehigh and those at other institutions, beyond that provided by electronic mail. External connections also allow access to databases and other information available on the Internet.

Conclusion

All levels of networking technology have implications toward education. Local area networks provide a medium for communications and sharing of information between people in close proximity, such as members of a class working in a microcomputer classroom. Campus-wide networks provide similar capabilities across the campus and also provide a means through which distributed resources can be shared. And finally, national and international networks provide a means for sharing information and resources far beyond the confines of the campus.

Although still in the formative stage, implications of networking technology toward education currently include specific learning applications such as language skills, problem-solving skills, and collaborative learning skills. As networking technology evolves, and audio and video capabilities become an even more integral part of it, increased opportunities to enhance the learning environment will become evident.

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Selected Abstracts for the

Special Interest Group for Computer-Based Training (SIGCBT)

COMPUTER-BASED TRAINING AMONG TOP AMERICAN BANKS

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Abstract

This research studied the use of Computer-Based Training (CBT) by major American banking institutions. The study is a replication of one done in the insurance industry and was made up of the top 150 commercial and 100 consumer banks. The CBT areas that the questionnaire focused on were: usage, administration, target audience, hardware and software, and types of course content.

Introduction

The rapid increase of CBT usage by major American corporations has been a phenomena in recent years. In 1988 a study was conducted of the use of CBT in the insurance industry (Rahmlow and Marsh, 1989). Seeking to extend the research in insurance into the banking industry, Nolf replicated the Rahmlow and Marsh work in a study among major American banks. The current study was conducted in the spring of 1989. The population for the study was made up of the top 150 commercial banks and 100 consumer banks as determined by assets.

Purpose of the Study

Corporations are spending more and more money on CBT as a training tool. Recent surveys (Lee, 1987; Spiegelman, 1987) indicate that approximately 53 % of American corporations, ranging from companies with 50 or more employees to the Fortune 500, use CBT. More importantly, these surveys show that many of the remaining companies plan to begin using CBT in the next few years.

How extensively are American corporations using CBT? In 1986, one survey (Ralphs and Stephen, 1986) of Human Resource Development (HRD) practices within the Fortune 500 companies reported that approximately 44 % of the responding companies are using some form of CBT. The results are somewhat misleading; because of the way the research question was worded, the extent to which CBT was being used compared to other training methods could not be determined.

The same study (Stephen, Mills, Pace, Ralphs, 1988) repeated two years later showed that only 17 % of the companies reported a high use of CBT. Reported usage of all technological advances in training, such as interactive video and satellite TV networks, huddled at the "almost never used" end of the scale. As the authors of the survey concluded, "In terms of significant use of contemporary technological advances in the field of training and development, these results are dismal" (p. 30).

The previous comment reveals the current conceptualization of CBT in the corporate environment as a "technological tool." The effect of CBT is to train employees to perform a function or task, the emphasis being to make training more efficient and cost effective. Therefore, the purpose of this study is to examine the following areas of CBT delivery among major American banks:

1. Degree of usage
2. Administration
3. Audience
4. Hardware and software
5. Types of courses

By sharing this data, the American banks can make more effective use of their training dollars.

Significance of the Study

American industries spent an estimated $30 billion a year on training. The amount sounds impressive, but as Peters (1987, p. 21), author of *In Search of Excellence*, points out, that is small change compared to the $400 billion spent on hardware. As he challenges, "We may have gotten away with our neglect of human capital development in days gone by, when cheap energy and the logic of mass production created operations that relied on narrow, specialized labor. But that world is long gone." The complex technology required for more efficient production needs a more educated work force which calls for better training.

A training methodology increasingly mentioned as a solution to this problem is CBT. However, any corporation wishing to utilize CBT in an educational and cost effective manner must recognize both its advantages and limitations. The benefits of CBT are mostly discussed in a technological or economic sense, while its most serious limitation is in the area of matching learner characteristics, such as a preference for individual or group instruction.

Development of CBT is expensive. It can take from 100 to 300 (or more) hours to produce 1 hour of CBT. As G. Gery (1986) points out, the more complex the courseware, the greater the development time. The average development cost per hour of CBT is $6,000.00; interactive video, which uses video and computers to deliver training, costs $12,000.00 per hour to develop (Diamond, 1986). Compared to classroom training, however, delivery costs for CBT are low. Selden and Schultz (1982) estimate these costs for classroom training are about 40 times more expensive than CBT over a 4-year period.

CBT does offer certain unique advantages in instructional delivery. Many authors (Snyder, 1987; Wehr, 1988) note such benefits as availability, interaction, self-paced student control, reinforcement, and realistic simulations.

The biggest disadvantage of CBT is that it may not match the preferred learning style of many trainees. Doty and Doty (1964) found that the students who benefit most from programmed learning have relatively low social needs and high academic ability. Dunn and Dunn (1978) suggest that programmed learning is more effective for highly motivated, responsible students who are visually motivated and do not work well in groups. Hopmeir's research (1981) indicates that introverts, who are task- and detail-oriented, do better with CBT courses than extroverts or perceptive learners.

The key to successful and effective CBT, as in any training media, is still instructional design, which takes into account the preferred learning style of the trainee. As Godbey (1978, p. 11) points out, "Good teaching is done by thinking first of how it affects the learner, not the teacher." J. Woolsoncroft (Snyder, 1987, p. 41) adds that "a CBT course, even if the content is good, can be useless unless it's got a good design to it."

Knowles (1980, p. 59) warns against "panacea-addiction" or "a compulsion for neat, simple solutions to complex problems." CBT may seem like the perfect marriage of technology to instructional design. However, unless all aspects of instructional design, including learner characteristics, are taken into account, the results may not be a perfect union but a messy divorce.

Limitations of the Study

Since the study involves a broad survey of many different banks, the following limitations should be considered:

1. The reason CBT was selected by the bank as opposed to some other training medium was not considered. More extensive surveys will have to provide comparison data with other training methodologies.
2. Evaluation of the effectiveness of CBT is considered beyond the scope of this surveyH. owever, any consideration of training methodology must ultimately address this factor.
3. The number of respondents may limit the representativeness of the survey. Since the survey is limited to only large banks, the results may not necessarily apply to mid- and small-size banks.

Even taking these limitations into account, this survey can produce information that helps banks improve their delivery of CBT.

Review of Literature

CBT usage by American corporations is increasing. It is, however, a relatively new training methodology. In recent years, most American corporations have been faced with rapidly changing economic conditions and the challenge of deregulation. In many industries, the Federal government has reduced or eliminated laws governing pricing and market areas. To respond to the increased competition, corporations have had to develop new products, improve customer service, and lower or control prices.

Technology, such as new software and improved hardware, is seen as a vehicle for meeting these challenges. CBT is viewed as a training technology that can provide large-scale and efficient training. However, CBT is relatively new, a product of the very technology that it makes more manageable. To understand the current status of CBT, it is necessary to understand how it developed and became prevalent in the corporate environment.

Use of CBT in the Corporate Environment. CBT is often spoken of as a training technology in its teenage years. For a sixties child, it is now in adolescence and still seeking direction. A. Packer (1988, p. 10), a researcher at the Hudson Institute, predicts that in the next decade, instructional delivery systems may pass data processing as the most common function of computers in American companies, a change dictated by the evolving skill requirements of a developing global economy.

Corporations began to use CBT as a training tool in the 1960s, although its early applications were limited. As early as 1976, IBM used CBT for internal training. At the same time, Control Data began to develop PLATO, an authoring and delivery system. As P. Holste (1988, p. 6) points out, "But it wasn't until this decade that the *<F14MI>need*<F255D> for training on and with computers became significant enough to fuel creative innovation and broad market growth."

In the 1980s, CBT exploded onto the corporate training scene. As late as 1984, 50 % of the trainers surveyed by the magazine Training (Trends, 1985) had little or no experience with CBT. By 1989, the annual survey showed that 43.3 % (up from 37.9 % in 1988) of United States organizations with 100 or more employees use CBT. Most companies use CBT to teach computer-related applications; however, an increasing number are using CBT to teach technical, management, and interpersonal skills.

Hirschbuhl (1987) recently completed a comprehensive survey of CBT among eight major American industries to determine the level of usage, development commitment, and user satisfaction. Some of his findings are:

- CBT is most frequently used for data processing training (20 to 30 %)

- Vendor-supplied generic courseware accounts for the vast majority (70 % in 1987) of CBT courses used by corporations. Internal development represents only 6 % of CBT usage and custom CBT makes up the rest.
- CBT use is division- or department-based, not centralized.

Hirschbuhl's summary of the commitment to use CBT for in-house training in 1987 among various industries is shown in Figure 1. Deregulated industries such as insurance, banking, and airlines have shown the greatest commitment to CBT; accounting firms used CBT the least.

Rahmlow and Marsh (1989) conducted an in-depth survey of CBT usage in the insurance industry. Fifty nine percent of the responding insurance companies report that they are using CBT. In 1978, a similar survey conducted by The American College Company Coordinators reported only 6 out of 400 insurance companies used CBT delivered on a mainframe system, the only choice since personal computers were extremely rare. Although CBT is only a small part of the total training effort, a significant increase in the use of CBT has occurred in the past ten years.

Since insurance companies and banks are financial institutions, much useful data can be compiled by replicating Rahmlow and March's survey in the banking industry. Are most banks using CBT? Are major banks, like insurance companies, using micro delivery more than mainframe delivery? Is the training department most often responsible for the administration of CBT? By answering these questions, both industries can benefit from their differing experiences.

The next topic presents an overview of CBT use by banking institutions.

CBT Use By Banks. Both the banking and insurance industries have been greatly affected by deregulation and intense competition. Banks have turned to CBT because its unique characteristics enable them to deliver training efficiently to large numbers of people. Banks also use CBT because of the significant cost savings particularly when compared to instructor-led courses. Zimmermann (1988) investigated use of CBT and interactive video by banks and found that the major reasons for using them were cost savings, convenience, consistency, reduced travel expenses, and decreased learning time.

When a bank is converting to a new software application, time is money. In 1985, Bank of Oklahoma converted nine recently acquired banks to a new deposit system. The bank used CBT to provide the training. As S. LaCross (CBT Programs, 1985, p. 110), conversion analyst, comments, "With CBT, we saved time. We also couldn't have covered [the material] as well or as consistently."

An increased emphasis on sales due to deregulation has forced banks to produce training about products such as types of savings accounts and special loan financing. The North American Finance Group of Citibank (J. Borger, 1988) uses CBT to deliver data about international products and marketing strategies. Compared to the previous year, usage by the 600 relationship managers, who represent the bank to institution customers, has increased by 20 % in 1986 and by 32 % in 1987. Sovran Financial Corporation (Pollock, 1989) is using CBT to teach a computerized retail sales program. By becoming more comfortable with the product, platform personnel can increase sales activity.

Banks are becoming more automated. As Hardwick (Zimmerman, 1988, p. 84), president of Electronic Learning Systems, says, "With so much information at the fingertips of the people who can change the business the tellers and platform personnel banks have to teach them how to use the systems effectively." Ward (1985, p. 3), a member of the Training and Development Department of First Union Bank, says, "With computer-based training, it will be easier for us to train employees to use the corporation's automated systems. Learning will be easier because the training will take place on the same equipment they use day-to-day....We cannot bring hundreds of branch employees into the corporate headquarters every time there is a new product or procedure to teach them." CBT was developed to fulfill the training needs of the expanding corporation.

Turnover is also a problem at banks necessitating repeat training at irregular intervals. As Roden (1988, p. 11) explains, "The turnover is phenomenal; some banks have 100 percent turnover among their tellers."

In short, CBT represents a training methodology able to deal with new technology in the work place, rapidly changing economic conditions demanding new banking products, and turnover from a changing work force.

Methodology

This study describes the methodology used to conduct the study. Topics are research questions, sample, instrumentation, procedures, and summary.

Research Questions. The following areas were surveyed:

1. Usage
2. Administration
3. Audience
3. Hardware and software
4. Types of courses

The following section lists and discusses each of these major research topics. On the actual questionnaire there may be several items addressing each of the above topics.

1. Is your Company currently using any form of computer-based education? The primary research topic sought to determine whether major banks were using CBT. If a bank was not using CBT, the questionnaire asked if use was anticipated within the next year and the type of system to be purchased.
2. Which Department has the responsibility for the administration of this effort? The second research topic established the department(s) that administer CBT. Individual departments, such as commercial lending or installment lending, may administer CBT within their own groups or CBT may be under the jurisdiction of an education or training department. Joint departments may also be responsible for its administration. Within larger financial institutions, subsidiary banks or even branches may control their own training.
3. Which of the following groups use courses you offer? corporate management, branch management, branch support staff, loan officers, loan support staff, operations officers, operations support, trust officers, other. The third research topic determined which groups within the bank were using CBT. For example, it may be used primarily for data processing or loan officer training
4. What type of microcomputer hardware are you using? Does your organization use modems with PC's? Does your organization use a LAN (Local Area Network)? What type of instructional system are you using? The fourth topic concerned the types of hardware and software used to deliver CBTCBT can be presented via a mainframe computer, a personal computer, or personal computers configured in a network. Numerous presentation systems are available for the range of hardware types.
5. How many hours of training are currently on your system? Please attach a list of courses. The last question concerned the types of courses offered. Respondents were asked to estimate the total hours of available CBT, provide a list of course subjects, and indicate how they were obtained developed in-house, purchased from outside vendors, or developed by consultants to the bank's specifications.

Sample

The population was made up of the top 150 commercial banks (finance business and commerce loans) and 100 consumer banks (finance loans to individuals for personal, family, or household reasons) as determined by assets. This listing was provided by the October 1988 issue of *American Banker*.

Current Federal regulations permit American banks to perform both commercial and consumer functions. Therefore, there was an overlap in the sample and some banks were in both categories, as shown in Figure 2. As a result, only 165 questionnaires needed to be sent.

Since the population was relatively small, questionnaires were mailed to the human resource directors of the entire population. Names were obtained from the 1988 North American edition of *Polk's Bank Directory*.

Instrumentation. A questionnaire, shown in Appendix A, was developed to address the research topics. In some cases, more than one item in the questionnaire dealt with a specific research question. This questionnaire was adapted from one used by H. Rahmlow and N. Marsh (1989) in their survey of CBT usage in the insurance industry and attempted to extend their original research.

The validity of the questionnaire was tested by submitting sample questionnaires to three experts, directors or managers of CBT at a bank. They were asked to analyze the content validity, or how well the questionnaire items measured the intended content area. They determined if the proper areas were surveyed and that there was a suitable number of questions to properly survey each topic. These experts also examined the face validity, or degree to which the questionnaire measured what it was intended to measure. The format and wording was revised based on their comments.

Reliability, whether the test consistently measures the same thing over a period of time, was not specifically investigated since this particular questionnaire was to be administered only one time.

Procedure. In February 1989, three selected human resource directors or their equivalent in CBT training were contacted by telephone to determine if they were willing to participate in the development of a survey on CBT in the banking industry. All three agreed to take part in the research. They were mailed surveys and asked to complete it and analyze its design. Based on their comments during follow-up calls, the design was modified. Their responses were used in the final tabulation of survey results.

On March 15, 1989, the human resource directors of the top banks in the United States were mailed questionnaires. A cover letter described the study and promised confidentiality. The participants were asked to return the questionnaire by March 31, 1989.

Also included was a letter from S. Switzer, President of the Philadelphia-Delaware Valley Chapter of the American Society for Training and Development (ASTD). This letter stated that the results of the survey were to be shared with trainers in the banking industry and other members of ASTD. It asked the respondent to participate in this consolidation of data on a new training technology.

Survey Results

This section summarizes the results from the 67 surveys returned. It analyzes the survey data to determine if the strategies used to develop CBT are reflected in its delivery by major American banks. The following areas are examined: degree of usage, administration, audience, hardware and software, and courses. It also discusses the response level and presents a study summary.

Degree of Usage. CBT usage among major banks is prevalent since 51 banks (77 %) use some sort of CBT. An additional 5 banks anticipate beginning to use CBT before the end of 1989. Several respondents indicated through marginal notes that the use of CBT is new and 2 banks noted that they are scaling down their CBT development.

Administration. As shown in Figure 3, the education and/or training department is responsible for all or part of the administration of CBT at 52 % of the banks. At 21 % of the banks, CBT is administered by data services. Joint responsibility between at least 2 departments is listed by 15 % of the banks. The remaining banks report that CBT was administered by a specific department such as commercial lending or trust. No historical data is available to determine if this trend of responsibility has been shifting over the years.

Audience. The audience, or job classifications, for CBT delivery does reflect a bias as shown in Figure 4. The highest use of CBT is reported in the operations area which is responsible for 30 %. The next highest usage is by loan officers and support staff (24 %). Branch management and support staff account for 23 % of course usage. The remaining course usage is other (12 %), trust officers (6 %), and corporate management (5 %).

The above figures categorize CBT usage by department. The same numbers examined by job classifications, regardless of department, show that training is about evenly divided between management (46 %) and support staff (42 %). Thus all levels of bank personnel are being trained by CBT. Some banks even indicated that everyone in the bank used some of the CBT courses.

Hardware and Software. The hardware and software results are as follows. Among those banks using mainframe course presentation, 47 % use Goal's Phoenix. Two of the banks anticipating using CBT before the end of the year also will use Phoenix. Only 11 % of the banks use IBM IIAS or IIPS as a mainframe presentation system. Since the other presentation systems have only one or two banks using them, Phoenix is clearly in the lead in the mainframe environment.

The micro computer hardware most often used is IBM (84 %). About 58 % of the banks use modems and 45 % report using Local Area Networks (LANs). However, marginal notes indicate that micro usage is hard to measure. For example, tutorials for micro applications are often distributed on floppies so that student usage cannot be tracked easily. Although the use of CBT is high at 77%, use of interactive video is limited at 14%.

Courses. Most of the CBT courses involve the computer or computer applications. A large number of courses involve learning programming languages or how to use the computer. Some courses are about using new software applications such as commercial lending. Other courses, such as Regulation C, involve changing government regulations in banking. A few courses concern improving professional skills such as writing. Even though course content cannot be specifically determined from the title alone, the trend for using CBT courses to present training on new technology or government regulations is quite clear. Not all banks provided lists of courses. The most frequently listed courses and the number of banks reporting them are:

Computer Software Courses	
Focus	4
DOS	3
JCL	3
CMS	2
Easytrieve	2
SAS	2
TSO	2
VTAM	2
Computer Hardware Courses	
Terminals	4
Computer Literacy Courses	
Basics	4
Data Processing	2
Electronic Mail	2
Banking Application Courses	
Commercial Lending	6
Customer Information Service	4
Branch Authoring	3
Check Processing	3
Deposits	3
Customer Information File	2
Safe Box	2
Trust	2
Banking Terminology Courses	
Products	5
Currency Transactions	4
Individual Retirement Account	4
Regulation C	3
Platform	3
CBT Related Courses	
How to Use CBT	3
Professional Skills Courses	
Writing Skills	5
Lotus	3
Performance Improvement	2
Stress Management	2
Time Management	2
Typing Skills	2

The number of hours of computer-based instructional courseware available at each site varies widely. The range goes from 0 (the bank was developing its first course) to 300 hours. The distribution is skewed to the low end with over half the banks having under 22 hours. This data is hard to interpret because many respondents had trouble determining this factor since a unit making up a CBT course may take from 5 to 45 minutes.

Most banks are obtaining their CBT courseware from outside vendors (53 %) or contracted developers (23 %). The banks who develop their own CBT (49 %) do so in a centralized (76 %) as opposed to a decentralized environment (24 %). Note that the percentages for obtaining courseware total more than 100 % since most banks use a combination of methods.

The majority of banks developing their own courses (59 %) are authoring only on the mainframe; 20 % are authoring in both mainframe and micro environments; and 9 % are authoring only in a micro environment. The remaining 12 % do not give a clear indication of how they are authoring.

Phoenix is the overwhelming choice for an authoring language (74 %). Every other language (Boeing Scholar/Teach, IBM IIAS/IIAP, SAM, etc.) is mentioned by only one or two banks.

Costs of authoring CBT are allocated as follows: Training or CBT department, 31%; No formal system, 19%; Other, 19%; Combination of methods, 15%; Sponsoring department, 13%; and Training and sponsor, 3%

Student usage is measured by the numbers of students who use CBT and the numbers of hours they spend on CBT. In the mainframe environment, banks report an average per month of 594 student hours for 286 students. In the micro environment, banks list a much lower average per month of 41 student hours for 24 students.

In conclusion, banks are offering CBT courses mainly about computers or computer applications, not about conceptual subjects such as problem solving skills or motivation. Most of the courses are obtained from outside vendors. The hours of use by students vary tremendously from bank to bank, but most of the recorded use is in a mainframe environment.

Response Level. The response rate was 41 % since 165 surveys were mailed and 67 returned. One of the surveys was unusable(The return indicated that CBT usage, if present, was controlled by the affiliate banks. Subsequent mailings to these affiliates produced no response.) This was a representative sample because the returns were evenly distributed by bank size and type. Because of this representation, it was decided not to perform a second mailing.

Results Summary. CBT is a training technology used by 77% of the responding banks. Most of the banks use CBT to train individuals in procedures such as programming or content specific areas such government regulations. The highest use of CBT is in the operations area (30 %) followed by loan officers and support staff (24 %). CBT is used to train both management and support staff. In general, the education and/or training department is responsible for all or part of the administration of CBT at 52 % of the banks; however, the data processing area administers CBT at 21% of the banks.

Conclusions

The study has documented the status of CBT among major American banks at the close of the decade. CBT is a training technology of growing importance. Given the relative infancy of the technology and the great significance of training in the banking industry, it will be important to further monitor the development of this technology.

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THE AT-RISK ADULT LEARNER: DEFINITION AND SOLUTIONS

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Abstract

There is a serious lack of provision of educational opportunities for AT-RISK adults. Many underlying problems relate to this lack of opportunity; four will be discussed. 1)the definition of an AT-RISK adult is not clear, 2)the need for lifelong learning and education opportunities for the AT-RISK adult learner remains unseen, 3) creating an environment for this population is a complex task, and 4) technological advances in education are not being utilized with the AT-RISK adults.

Determining solutions for the lack of provision of educational opportunities for the AT-RISK adult is complex. Four solutions will be described: 1) review and compare methodologies utilized in countries around the world, 2) consider instructional design as an alternative research paradigm, 3) examine the possibilities of Outdoor and Computer Education for Adult Needs Ranch, and 4) examine the possibilities of using an affective domain instructional model within the Outdoor Computer and Education for Adult Needs Ranch.

There is a serious lack of provision of educational opportunities for AT-RISK adults. Many underlying problems relate to this lack of opportunity; four will be discussed. First, the definition of an AT-RISK adult is unclear. Second, normal adults are only beginning to see the need for lifelong learning and education opportunities, therefore the AT-RISK adult learner continues to remain unseen. Third, creating an environment for this population is a complex task. Finally, technological advances in educating the special needs population have only been utilized with children and with a select group of adults.

At-Risk Definition

How can the AT-RISK adult be defined? One method, although somewhat cold, is to identify and classify the members of this population. AT-RISK *depicts a potential or minimal amount of potential for change.* Three population groups are described as having a potential problem with learning/educational change.

Children with Developmental Disabilities are often given an appropriate education until age 18. When they reach adulthood their educational opportunities become minimal. Group one is identified as the adult Developmentally Delayed.

A second group of AT-RISK adults are the functionally illiterate. These people have successfully managed to remain employed, maintain relationships, and often raise children. Literacy groups are only beginning to develop educational programs to meet the needs of these adults.

The third group of AT-RISK adults are those with psychological problems. Reasons for these problems may vary, however they have a serious effect on learning. Often the psychological issue may be addressed but not in relationship to learning.

There may be additional groups within the AT-RISK definition. However small and simple, these three groups are the beginning of an understanding of this population and its educational needs.

Normal Adults/Life-Long Learning

The second problem in providing educational opportunities for the AT-RISK adult is directly related to how normal adults are just beginning to recognize the need for lifelong learning. Five examples of contemporary adult learning theory will be highlighted to offer better understanding of the foundations of adult learning.

Carl Jung advanced a holistic conception of human consciousness, introducing the notion that it possesses four functions; sensation, thought, emotion, and intuition. His plea for the development and utilization of all four functions in balance laid the groundwork for the concepts of the balanced personality and the balanced curriculum.

Erik Erikson provided the "eight ages of man," the last three occurring during the adult years, as a framework for understanding the stages of personality development:

1. Oral-sensory, in which the basic issue is trust vs. mistrust.
2. Muscular-anal, in which the basic issue is autonomy vs. shame.
3. Locomotion-genital, in which the basic issue is initiative vs. guilt.
4. Latency, in which the basic issue is industry vs. inferiority.
5. Puberty and adolescence, in which the basic issue is identity vs. role confusion.
6. Young adulthood, in which the basic issue is intimacy vs. isolation.
7. Adulthood, in which the basic issue is generativity vs. stagnation.
8. The final stage, in which the basic issue is integrity vs. despair.

In fact, the central role of self-concept in human development and learning received increasing

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reinforcement from the entire field of psychiatry as it moved away from the medical model toward an educational model in its research and practice.

Maslow placed special emphasis on the role of change, as becomes clear in the following formulation of these elements in the growth process:

1. The healthy spontaneous person reaches out to the environment in wonder and interest and expresses whatever skills they have.
2. To the extent that he/she is not crippled by fear, to the extent that he/she feels safe enough to dare.
3. In this process, that which gives him the delight-experience is fortuitously encountered, or it is offered to him by helpers.
4. He/She must be safe and self accepting enough to be able to choose and prefer these delights, instead of being frightened by them.
5. If he/she can choose these experiences which are validated by the experience of delight, then he/she can return to the experience and repeat it.
6. At this point, he/she shows the tendency to go into richer, more complex experiences and accomplishments in the same sector.
7. Such experiences not only mean moving on, but also have a feedback effect on the Self, in the feeling of certainty, capability, mastery, self-esteem, and self-trust.
8. In this ending series of choices of which life consists, the choice may generally be schematized as between safety and growth.
9. In order to be able to choose in accord with his/her own nature and to develop it, the individual must be permitted to retain the subjective experiences of delight and boredom, as the criteria of the correct choice.
10. If the choice is really a free one, then we may expect him/her ordinarily to choose progression forward.
11. The evidence indicates that what delights the healthy person is also "best" for him/her in terms of far goals as perceivable by a spectator.
12. In this process the environment is important in many ways, even though the ultimate choice must be made by the individual;
    - a.) it can gratify his/her basic needs for safety, love and respect, so that he/she will not feel threatened, autonomous, interested, spontaneous, and thus dare to choose the unknown;
    - b.) it can help by making the growth choice positively attractive and less dangerous, and by making regressive choice less attractive and more costly.
13. In this way the psychology of Being and the psychology of Becoming can be reconciled, and the person, simply being him/her self, can yet move forward and grow (Maslow, 1972).

Lindeman, a pioneering theorist, portrayed a new way of thinking about adult learning. Lindeman here identifies several of the key assumptions about adult learners that have been supported by later research and that constitute the foundation stones of modern adult learning theory:

1. Adults are motivated to learn as they experience needs and interests that learning will satisfy; therefore, these are the appropriate starting points for organizing adult learning activities.
2. Adults' orientation to learning is life centered; therefore, the appropriate units for organizing adult learning are life situations, not subjects.
3. Experience is the richest resource for adults' learning; therefore, the core methodology for adult eduction is the analysis of experience.
4. Adults have a deep need to be self directing; therefore, the role of the teacher is to engage in a process of mutual inquiry with them rather than transmit his or her knowledge to them and then evaluate their conformity to it.
5. Individual differences among people increase with age; therefore, adult education must make optimal provision for differences in style, time, place, and pace of learning.

It is interesting to note that Lindeman did not dichotomize adult versus youth education, but rather adult versus "conventional" education, thus implying that youth might learn better, too, when their needs and interests, life situations, experience, self-concepts, and individual differences are taken into account.

Knowles presents the skeleton of a lifelong learning model. This model consists of several assumptions and elements; two are mentioned.

The first assumption is that the purpose of education is the development of competencies for performing the various roles required in human life. The first element in the model is a taxonomy of these roles and their required competencies as shown in Table 1.

The second assumption is that the primary purpose of schooling is to help children and youth learn the skills of learning. The ultimate behavioral objective in school should be: "The individual engages efficiently in collaborative self-directed inquiry in self-actualizing directions". Knowles believes these skills include at least the following:

1. The ability to develop and be in touch with curiosities.
2. The ability to formulate questions.
3. The ability to identify data required to answer questions.
4. The ability to locate the most relevant and reliable sources of required data.
5. The ability to select and use the most efficient means for collecting the required data from the appropriate sources.

6. The ability to organize, analyze and evaluate the data so as to get valid answers to questions.
7. The ability to generalize, apply, and communicate answers to the questions raised.

Many researchers and theorists in both education and psychology have contributed information critical to understanding the adult learning process. Carl Jung advanced a holistic conception of human consciousness. Erik Erikson provided the "eight ages of man," as a framework for understanding the stages of personality development. Maslow placed special emphasis on the role of "safety" in an educational sense. Lindeman, a pioneering theorist, portrayed a new way of thinking about adult learning. Knowles presents the skeleton of a lifelong learning model, on which to build. From these and others adult learning is investigated and understood.

Table 1. Competency Development for Life Roles

Roles	Competencies
Learner	Reading, writing, computing, perceiving, conceptualizing, evaluating, imagining, inquiring
Being a self (with unique self-identity)	Self-analyzing, sensing goal building, objectivizing, value-clarifying, expressing
Friend	Loving, empathizing, listening, collaborating, sharing, helping, giving feedback, supporting
Citizen	Maintaining health, planning, managing, helping, sharing, buying, saving, loving, taking responsibility
Family Member	Caring, participating, leading, decision-making, acting, "conscientizing", discussing, having perspective (historical and cultural)
Worker	Career planning, technical skills, using support, giving supervision, getting along with other people, cooperating, planning, delegating, managing
Leisure Time-User	Knowing resources, appreciating the arts and humanities, performing, playing, relaxing, reflecting, planning, risking

Creating an Environment

The third problem in providing educational opportunities for the AT-RISK adult is in creating an environment to meet the educational needs of this population. To understand the complexity of developing such an environment three examples are provided relating to type of adult learner previously defined.

The Association for Retarded Citizens (ARC) offers funding for group housing , work environments, and education for the Developmentally Delayed adult. In Colorado there are Independent Living Centers, Center for People with Disabilities, Atlantis Community, and Denver Center for Independent Living as well as a variety of private facilities.

The Colorado Literacy Assistance Center (COLAC) has developed tutoring programs and a statewide telephone network, Hotline. In March, 1990, COLAC will hold a forum to discuss definition and possible legislation to assist statewide literacy programs.

Psychiatric outpatient, inpatient, long and short term facilities assist those with psychological problems nationwide. The forms of care vary as does the educational environment. The immediate concern, for the AT-RISK adult is one of connection between therapy and learning.

There are limited learning opportunities available for the AT-RISK adult. The population and the need are vast. This complexity constrains planning, funding and operation of an appropriate environment for the AT-Risk adult.

Use of Technology

The fourth problem in providing educational opportunities for the AT-RISK adult is utilizing technological tools to enhance learning. Children have many advantages in method of instruction. Computers, interactive video, and other technological advances have been developed to meet the educational needs of children with disabilities. Occasionally, on university campuses, in public libraries, or job settings technology is available to the adult learner. Unfortunately, there are few specific settings accessible to the Developmentally Delayed, illiterate, or psychologically troubled adult.

After discussing four areas within this complex problem of providing educational opportunities for the AT-RISK adult it is clear that many overlapping variables exist. These problems are very real and seriously effect the lives of hundreds of thousands of adults around the globe. It is critical that solutions be explored, created and developed.

Solutions

Determining solutions for the lack of provision of educational opportunities for the AT-RISK adult is a complex endeavor. Four possible solutions will be described: 1) review and compare methodologies utilized in countries around the world, 2) consider instructional design as an alternative research paradigm, 3) examine the possibilities of Outdoor and Computer Education for Adult Needs, and 4) examine the possibilities of using an affective domain instructional model within the Outdoor and Computer Center.

Review and Comparison of Worldwide Models

Alexander Charters and his associates (1981) have compiled research comparing adult education worldwide. To better understand the complexity of providing educational opportunity for an diverse AT-RISK population three examples of adult education are described. Adult education in Australia, Burma and Iran are briefly described in Table 2, according to six categories. These three countries were chosen by Chris Duke in his study, *Australia in Asia-Comparison as Learning*. Each country was compared on several variables, including these six. All of the above information is described in detail in Duke's paper and offers many conclusions. It is interesting to note the variety of the subjects in each country and the perspective that government and business take in each country. This research documents a wealth of data, not the least of which points to the large diversity in population need and programming challenges for adult learners.

Table B. Characteristics of Comparative International Adult Education

	AUSTRALIA	BURMA	IRAN
DEFINITION	Functional Literacy, Recurrent Continuing Education	Literacy Training, Nonformal	Literacy Training, Nonformal
PURPOSE	Liberal Arts, Social & Community change, skill improvement in labor	literacy is first, functional application is secondary	national community-based literacy
SUBJECTS	Post secondary education	No age restrictions	over age 11
OPPORTUNITY	community and university based, private and public	vast, group pressure is used to take people to literacy classes	vast, 6,000 communities, government organized
RESOURCES	non-government agencies, community-based movements as learning exchanges	Central Literacy Committee, Political Party & Business leaders are decision makers	Minister of Education: large national center, large field operations
LIMITS	no federal planning, direction, or coordination, only statewide (much variety)	Education gets less money than agriculture, industry or transportation	regional diversity in population, programming instruction

Instructional Design/Alternative Research Paradigm

Systematic instructional design contains a cycle of detailed phases. There are many models and many methods to accomplish each phase. The basic five step model will provide a scaffolding to develop instruction for the AT-RISK adult. This model includes Analysis, Design, Development, Implementation, and Evaluation.

Malcolm Knowles describes a group of techniques developed for Westinghouse Managers Training in *The Adult Learner: A Neglected Species*. The starting point, front end analysis, asking Westinghouse management to develop a list of essential competencies required to perform 'the role of General Manager. A list of 123 items were grouped into six traditional areas: marketing, engineering, manufacturing, finance, personnel and general management. Then six task forces were established, one for each of the functional areas. These task forces, chaired by an assortment of management personnel, determined what and how much a general manager needs to know in the specific function areas.

O.C.E.A.N. Ranch

The Outdoor and Computer Education for Adult Needs (O.C.E.A.N.) Ranch is being developed in Colorado to meet the educational needs of all adults; normal and those with special needs. The environment, a combination of outdoor and computer learning centers is an experimental design. Research has clearly documented the educational potentials of outdoor education (Lappin, 1984; Robb, 1983; Mobley, et.al., 1988). Equal educational success has been found using microcomputers as an instructional tool (Heerman, 1986; Davis & Marlow, 1986; Thomas, 1983). The O.C.E.A.N. Ranch is in the development process. Within the first phase, "analysis" the following steps are underway to insure need:

1. Needs assessment: special needs, AT-RISK and normal adult learners will be interviewed and surveyed, 200 throughout Colorado.
2. Curriculum development: review curriculum models within the four areas (basic and life skills outdoor skills, and the arts) and 50 instructors in each area will be interviewed, throughout Colorado.
3. Assessment development: review of assessment techniques within the four curriculum areas and interviews with 50 evaluation experts, throughout Colorado.
4. Analysis and interpretation of all information collected.

Affective Domain Instructional Development Model

The affective domain is often refered to as the attitude a learner may require prior to learning intellectual skills and verbal information. Martin and Briggs (1986) describe interaction as a process analyzed by "audit traits". These are single guides for sequencing experiences leading to attitudinal change. Within the "audit traits" the attitude to be acquired is related to other skills that facilitate acquisition. Martin and Briggs also have reported that cognitive behavior has affective components. Gagné (1985) defines affective domain as a choice of a course of personal action toward an object, person or event.

Within the scope of the affective domain an instructional development model will be designed and studied within the O.C.E.A.N. Ranch environment.

Conclusion

It has been established that there is a serious lack of provision of educational opportunities for AT-RISK adults. Many underlying problems relate to this lack of opportunity; four have been discussed. Determining solutions for the lack of provision of educational opportunities for the AT-RISK adult is a complex task. Many possible solutions exist. It is essential to pursue both an understanding of the problems and solutions evolving around the AT-RISK adult learner.

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CHOOSING OPTIONS FOR INSTRUCTIONAL DESIGN TOOLS

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Introduction

Instructional design is a technology that has matured over the past three decades but which remains difficult to apply by inexperienced personnel without formal training in the field. Yet a great deal of course development for the training requirements of the military, of public organizations, and of industry is actually carried out by such personnel, with the result that the materials produced are often of very unequal quality. This problem leads to time and cost consequences which can greatly impair the training capability of these organizations.

Different approaches to alleviate this problem have been proposed in the instructional R&D community. The principal one is to develop expert systems which can assist in the instructional design process. Other approaches include template aids, design tool boxes, and authoring macros within computer-based training authoring systems.

In the process of examining ways to improve the course development cycle within an on-going development context (specifically, CBT course production for aircraft maintenance training), we have been involved in an examination of the practical value of these approaches as useful instructional design tools. We consider in this paper the options we have examined and describe the approach we finally adopted. The latter led to the prototyping of a storyboarding tool currently in use within the course production program mentioned above (and described in an accompanying paper - Wang & Wunderlich, 1990).

Starting with the design of this storyboarding tool for the phase of course design which immediately precedes the preparation of training materials, such as inputting materials into a CBT (computer-based training) authoring system, we intend to branch out from there to design an up-front instructional design tool to assist in lesson design decision-making. Our eventual emphasis is on knowledge-based tools which can help structure the instructional design process and guide the relatively inexperienced course developer in preparing training materials.

We are building on the lessons learned from the practical examination of existing design aids in the field and tailoring our prototyping efforts to the real needs expressed by a course design team engaged in a large-scale training program.

The Need for Instructional Design Assistance

The production of CBT materials for large-scale projects aimed at increasing manpower preparedness within the public sector and industry is a lengthy and costly process which strains both training schedules and training budgets. Any improvements in the mechanics of the development process which might reduce time or cost of development or improve the quality of training would be very welcome.

Instructional systems design was developed into a strong technology in the 1960s and 1970s to structure the process of course development. This technology, albeit still in the process of evolution and refinement (Reigeluth, 1983, 1987), has been applied with success to large-scale training development. The ISD technology, however, is one which itself requires training and experience to apply correctly to novel training requirements which have not been previously met or which are emerging as the operational environment increases in technological sophistication and in complexity.

Many large-scale training development efforts are manned only partly by course developers with advanced training and experience in instructional design. A fair proportion of course development is actually accomplished by personnel who might have had prior experience in the training field (for instance as an instructor) but who have not had to handle sophisticated training problems involving individualized interactive instruction as made possible by computer-based training and the newer technologies. Because of this, there is great variability in the quality of initial materials produced for training, which leads to the associated need to correct and otherwise improve these initial materials so as to meet quality criteria for effective training. The time and costs associated with this situation can mount quickly and thus put a serious strain on the organization's training capability.

The core problem thus being addressed in the project described here is the lack of quality consistency in the initial training materials being prepared in large-scale training programs for the public sector and industry, as well as the high costs associated with the preparation of these materials.

Options for Instructional Design Assistance

The goal of any instructional design tool is twofold: first, to assist the instructional designer, especially the inexperienced one, through the provision of a more structured design context which can guide the actual preparation of instructional materials; second, to provide ease of use, which will enhance the smooth flow of the designer's train of thought as he or she engages in instructional design. There is a balance to be achieved here between structuring the process enough to attain uniform quality on the part of many designers of unequal competence, and nevertheless having a user-centered system which enables the taking of initiative and a responsible creative approach to design.

State-of-the-art technology in computer science, and particularly in the area of artificial intelligence, can be profitably applied in this area. AI is already being applied successfully to the development of intelligent tutoring systems (Wenger, 1987; Psotka et al., 1988; Polson & Richardson, 1988). The time is now thought to be ripe to likewise apply AI to the instructional design process, essentially in the form of expert systems which can advise on the proper design of instruction.

Expert systems are exemplified by the IDExpert being developed by D. Merrill and his team (Merrill, 1987, 1989). Such a tool requests from the instructional designer information regarding the specific nature of the training task and infers from this information guidelines which help define the structure of the instruction as well as suggestions for the planning of appropriate instructional interactions. We have closely examined this tool in its current prototype version, and believe that the orientation of this line of research is sound. However, the efforts to date are still in an early state of development, with the result that ease of use has not yet been achieved.

Other approaches to assisting instructional design are template aids, design tool boxes, and authoring macros within CBT systems. Template aids provide skeletal structural elements which can be filled in or adapted to the specific circumstances of the instruction being developed. They are illustrated by the software tools developed to help with such tasks as task analysis, writing learning objectives, or storyboard authoring. This seems to be an easily appropriated and powerful approach to assisting instructional design (eg. Sullivan & Heiben, 1988). It is the approach we have pursued in more detail in our own course production process, as described later.

Design toolboxes provide manipulable structural elements which can be combined into a CBT lesson which is immediately executable. They are perhaps best exemplified by CBT authoring systems such as Course of Action or Course Builder, both of which capitalize on the ease of use of the direct manipulation iconic interface capability of the Macintosh. The approach offers the instructional designer the opportunity to easily create CBT lessons without extensive prior planning or knowledge of programming. These systems enable the course author to structure a lesson and fill in that structure with domain content in a very accessible way, creating on the spot a lesson which is immediately usable by students. The ease of use of these systems is both their strength and their weakness. Indeed, they enable quick prototyping and easy revision, thus facilitating trial and error in design; however, they offer little in the way of instructional design guidance, although the eventual inclusion of templates in these tools (Misselt, 1989) will certainly help remedy this situation.

Authoring macros are structured lesson input instructions within CBT authoring systems which aim to overcome the lengthy programming involved in developing CBT with sophisticated presentation systems such as WICAT or AIS II. They are not instructional design aids per se, but rather programming aids; nevertheless, any authoring macro incorporates an inherent instructional design template which is instantiated during code production and which therefore structures the design process, thus by default guiding the instructional designer during lesson preparation. This has a high structural function, forcing the design into the predetermined template, which rather limits the designer's ability to adapt the design in a refined way to the particulars of the material. The main advantage of authoring macros lies in speeding up the production of CBT lessons while ensuring uniform quality. They are quite akin to templates in this respect.

The Practical Approach Chosen

Our task was, and still is, to evaluate the practical value of instructional design aids in an intensive course development context, as well as to undertake the prototype development of computer-based design aids in response to expressed needs of instructional teams involved in course development.

Our assessment of a state-of-the-art instructional design expert system provided to us by a government R&D agency revealed that this technology, while applicable in theory, is just not ready yet, in the practical sense, to be implemented in a real-world instructional design setting. The main problems which this assessment brought to light were the restricted knowledge base applied to the task, the rigidity of the prescriptive orientation provided, and the lack of user support in using the tool. These are all problems which further development can, and most likely will, overcome. For now, however, the promise of a useful instructional design expert system remains unfulfilled.

We realize that we have not exhausted the possibilities in this area and we see the need to explore the use of related design tools which were developed under different circumstances, such as the IDE developed at Xerox PARC (Russell et al., 1988) and the Curriculum Design System developed at the Alberta Research Council in Canada (Wipond & Jones, 1988). We plan on examining these and other similar tools in view of the practical design tasks of our on-going course development programs.

We have also set aside, for now, the available instructional design tool kits, essentially because they are very system dependent and lead to the development of instruction which lacks some of the instructional management features of the more sophisticated CBT systems. Until these limitations are removed, and until these tools offer a somewhat more disciplined approach to instructional design, they will not provide a useful set of tools for the production of large-scale training systems, even though they may prove to be valuable as CBT quick prototyping tools.

Authoring macros present a different perspective altogether. They are currently in use in the training design program with which we have been associated. They are seen,however, as a mixed blessing: on the one hand, they constrain the design process to what has been pre-defined as good instructional strategy for the particular content to be taught; on the other hand, they tend to perhaps make the training materials too uniform and possibly unduly restrict the instructional designer's scope for truly refining the materials.

What we ended up focusing on at this stage of the project was an instructional design tool that helps the designer freely construct lesson designs, while at the same time make use of templates that can expedite parts of the process. The tool can thus be categorized as a template aid, although the larger part of its functionality, as we shall see, focuses on enhancing the ease with which the designer can put together instructional specifications for the production of lesson materials. Our eventual aim is to increase the tool's design functionality through the application of design knowledge, while nevertheless preserving the primacy of the designer's control over the design process. Our goal is to keep mid-way between the extremes of a prescriptive expert system on the one hand and the looseness of a design tool kit on the other. Our approach has been to prototype a tool that is fully responsive to the perceived needs of instructional designers while at the same time offering the opportunity of suggesting design possibilities as these are embedded in interaction templates.

In the long term, the project is aimed at installing computer-based tools in a variety of training development projects so that program teams developing instruction are provided with the most productive development environments possible. For the moment, the project is oriented to the instructional needs of one particular course production program currently underway in the company (the MD11 aircraft maintenance training program), but the resulting tools will be generalizable and should be easily adapted to the needs of other training programs.

Specific Approach

Our initial approach has been to concentrate on the design of a storyboarding tool which can immediately assist the course development process in the MD11 program. The program team currently considers storyboarding as the area where the greatest need exists for a design aid tool.

Storyboards are an important product in the ISD production process for a variety of CBT situations. Within the lesson development phase, a storyboard document specifies the structure and details of the instructional interactions with the student (CBT frames) according to the training objectives and related content material defined for that lesson. The quality, consistency, and ease of development of storyboard documents has a significant effect on the effectiveness and development cost of the resulting training system.

Several course production programs within our organization are using a word processing method for the creation and revision of storyboard documents. This approach has brought many practical problems to light which impact on quality and productivity.

Communication is one key area where improvement is needed. Storyboard documents are reviewed and used by a variety of people within the MD11 maintenance training project. Quality of the end product demands that storyboard documents communicate an accurate sense of what an executing CBT lesson will look like so that the multiple reviewers, as well as the lesson programmers, can all properly visualize the intended finished product.

In particular, the training lessons being designed are a dynamic mix of text, audio, and graphics; however, the previous word processing approach only supported textual specifications of the on-screen text and audio, plus the instructions for graphic dynamics. Actual graphic images were referenced as an attachment to the storyboard document. The various reviewers and users of this document then had to imagine how the lay-out of the screen and the various dynamics would look like to the student.

Consistency of presentation is also an important contributor to the quality of the instructional materials. Consistency helps the reviewers, and eventually the students, to better predict and understand what is happening during lesson presentation. An unstructured word processing tool provides no guidance or framework within which to consistently present the same types of lesson elements in the same way. A storyboard tool does.

The structured storyboard development tool which we have built addresses many of the problems just mentioned. In particular, it enhances communication via a mixture of text and graphics, where graphic representations of the display screen for each lesson frame are embedded within the storyboard document along with associated descriptive textual and audio instructions.

The initial review and editing of frames are facilitated by extensive navigation features which allow efficient hypertext-like access to any structural part of the document based on content (terms, graphics, etc) or structural type (frame types, screens, instructions, audio). In addition, screen representations can be quickly stepped through to provide a very visual sense of the flow of a given lesson. Both consistency and instructional expertise are enhanced by the use of a flexible template system capable of supporting both lesson templates embodying instructional strategy and frame templates which give structure and guidance at a more micro-interaction level.

These functional features are embodied in the storyboarding tool TORUS, developed in HyperCard for use on Macintosh computers. The specifics of the tool are described in Wang and Wunderlich (1990).

Conclusions

Our experience in this project has confirmed to us the value of instructional design tools for somewhat inexperienced personnel involved in the production of training materials. We have not been able to determine whether our particular application has resulted in production time savings derived from a theoretically more efficient instructional design process. Too many other factors involved in the practical world of large-scale course production hampered our efforts to measure efficiency objectively. In our particular case, it appears that the instructional design process took as long as usual (perhaps even longer in certain circumstances) with the storyboarding tool.

Two qualitative elements surfaced clearly, however, in our assessment of this tool. The first is the improved quality of the storyboards, as assessed by those who have to review them. The second is the general enthusiasm of the instructional designers working on the project for this ID tool. There were some reticences, to be sure, but overall, the tool and what it offered were very well received by the user group for which it was destined.

The central question explored in this paper was the relative value of different options for instructional design tools. The primary issue which arises in this respect seems to be the trade-off involved in providing, on the one hand, strong enough structure and guidance so that the less experienced instructional designer produces instruction of uniformly high quality, and, on the other hand, enough elbow room for the more experienced designer to not feel constricted in what properly remains an applied soft technology requiring professional judgement and flair.

The two basic functional requirements for a sophisticated ID tool, structure and opportunity, are thus in conflict. What needs to be considered, therefore, is perhaps not so much how these two functional features can be combined within one tool, but instead how the support offered by these features can be made available to the instructional designer on an as-needed basis. The essence of the orientation which is now developing in this respect is the concept of an instructional design workstation which can provide a range of functional features, rather than concentrate on a tightly prescribed functionality, as is usually the case with individual tools. The orientation is evolving towards a much more user-centered approach to tool provision, an approach which is adaptive to different styles and levels of competence in designers, and which is therefore much more empowering for the individual designer.

The scale of the ID tool design effort has increased with this new orientation, but at the same time, the hope of a feasible solution to the question of practical value in real production contexts has also emerged. Exciting developments can be expected in this area of instructional design in the next few years.

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Selected Formal Papers from the

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TOWARD A MODEL PROGRAM OF UNIVERSITY-SECONDARY SCHOOL INTERACTION: ENHANCED MATHEMATICS INSTRUCTION THROUGH COMPUTER INTEGRATION

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Abstract

The first two years of a long term project to improve mathematics instruction through the integration of computer use in 5th through 12th grades of five New Jersey school systems is described. It is based on structured relationships with the district's personnel at all levels. It is intended to affect instructional practices, develop instructional materials applicable nation wide, and to create successful models for university-secondary school relationships.

Project Background and Overview

Since July, 1988 Stevens Institute of Technology has been engaged in a project with five New Jersey school systems of diverse socioeconomic and racial backgrounds to:

1. improve mathematics instruction by having teachers effectively use computers in 5th - 12th grade mathematics courses,
2. develop dissemination materials for classroom use and in-service teacher training regionally and nationally, and
3. test a model for effective college-school system relations.

A project premise is that school system-wide involvement and support is vital for successful development of new teaching methods, especially those involving technology; the project involves teachers, resource people, department heads, curriculum coordinators, principals, superintendents, and school boards.

Project History and Accomplishments to Date: July 1988 - July 1990

The Project was started in July 1988 as the primary activity of the Center for Improved Engineering and Science Education (CIESE), which was established by Stevens President Harold J. Raveche in July 1988 with support from Stevens internal funds.

During the fall of 1988 collaborative agreements were established with five socially, ethnically, and economically diverse school systems through negotiations with their superintendents, high school principals, and mathematics department heads. Initially the school systems were asked to provide only:

- stipends for teacher involvement in summer workshops, and
- released time for teacher participation in meetings and discussions relating to the project.

Teacher participation was voluntary but it was done in consultation with principals and mathematics department heads.

There are 30 teachers in the high school component, which we classify as being 9th though 12th grades, and 22 teachers in the 7th and 8th grade component. We are planning to extend the program to about 30 more teachers in the 5th and 6th grades. Most teachers had only a moderate exposure to computers, some as programming teachers, and none had used computers to teach mathematics. Project faculty and staff met with the teachers at each high school as a group four times in the spring of 1989 in preparation for the summer workshops. Based on these discussions we were able to identify and purchase, in time for the summer workshop, some 50 programs potentially useful for the identified curricular topics and modes of use. Since then we have acquired over 200 programs.

High School Component Activities

The first 9th - 12th grade teacher summer workshop took place for ten days in July 1989. There were 4-5 hours each day during which the teachers were able to check out any software they wanted to investigate and spend time learning it. Attendance at the one or two presentations each day was voluntary.

At first many of the teachers were uncomfortable with the loose structure of the workshops. Some wanted to be told what to do and how to do it. We refrained, indicating that effective use of computers was highly personal and had to be integrated with each teacher's style and emphasis. We encouraged them to explore several programs in the topics they taught indicating that the programs were more or less beneficial when used in conjunction with different teaching styles. By following this advice, some teachers indicated that they explicitly realized some of the aspects of their teaching style and by the end of the first 3-4 days all appreciated the freedom and went about software evaluation comfortably. By the end of the summer workshop all the teachers were comfortable with computer based curriculum materials, had identified opportunities for its use, and were preparing to implement some computer based activities in the coming academic year (1989-90).

Initially, most of these implementations took the form of demonstration as part of regular classroom lectures and group problem solving. In four of the high schools several classrooms were eventually equipped with a computer, display projector, and screen on which the teacher could display images to the entire class. In two of these, the computer and projector were mounted on movable carts to be used in various classrooms.

Two of the teachers in one school prepared detailed lessons for display of trigonometric functions, using Discovery Learning in Trigonometry developed by John C. Kelly and distributed by CONDUIT. This module took more than half the fall marking period. The teachers reported being able to show plots of 20 or more functions in each 40 minute class, resulting in having students see and work with many more functions than could have ever been possible without the computer generated displays.

Another teacher prepared scripts showing steps in the solution of algebraic equations using the Mathematics Exploration Toolkit developed by WYCAT and distributed by IBM. She had the program display the equations and pause while the class worked on the problem as a group. The class entered suggestions as to the next step and the computer pursued that solution line. Students were able to see quickly the results of their suggestions which might not be apparent for several steps. The computer kept a trace of all the inputs and intermediate results, allowing for review and comparison of solution attempts long after the information on a blackboard might have been erased. The teacher reported greatly increased interest among the students with some improvement in test results.

In a geometry class the teacher reported using the Geometry Proof Tutor, developed in the laboratory of John Anderson at Carnegie Mellon University as an intelligent tutoring system. It uses network representations of geometric proofs. The teacher reported that having the students be able to see that representation, as well as the traditional one using two column tables of proof steps and constructions, enhanced learning. She indicated that drawing, and redrawing, these representations on the blackboard as the class made suggestions would have taken far too long for the short class periods in the school. The computer was able to display these network diagrams, generating and modifying them as fast as the students could make the suggestions and enter the data.

This same teacher reported using one of the Geometry Supposer series in a one computer classroom demonstrating certain constructions and having groups of about 1/3 her class do assignment with the computer while the other 2/3 used conventional paper and pencil exercises. In a lesson that normally took two or three days she was able to train the class on the use of the machine, have them learn the material, and do all the exercises in the same time period that the class took to just learn the materials and do the exercises without the computer; this as the result of having the computer reduce the often laborious effort to develop geometric constructions with conventional drafting tools and supporting the measurement of angles and line segments.

During the fall of 1989, President Raveche and Dr. Friedman visited with four of the collaborating school boards at one of their regular meetings reporting on the project and discussing Stevens' commitment to the project and the importance of its goals in the context of U.S. education. Representatives of the schools and many of the teachers attended these sessions.
As a direct result of these meetings, additional resources have been allocated for computer integration into mathematics education. In Hoboken, for instance, the board allocated funds for overhead projectors, liquid crystal computer display screens, and carts to hold the computer with its associated projection equipment for each teacher in the program. In Bridgeton, in addition to added school board allocations, the local business community has been engaged in fund raising and contribution efforts as a result of the publicity associated with President Raveche's visit.

Seventh and Eighth Grade Component

The 7th and 8th grade program began in the fall of 1989 with visits by Dr. Friedman with superintendents and principals to identify the teachers involved. The focus of the 7th and 8th grade program is on word problems, introductory algebra, introductory geometry, arithmetic, graphing, and estimation.

In the spring, visits with teachers elicited topics for which the teachers were interested in having the use of computers; software was identified and purchased in preparation of the 7th and 8th grade teachers workshop in July.

All 32 7th and 8th grade teachers attended a two week workshop in July 1990 to review software and plan for academic year 1990-91 exploratory use of computers in their classes. This group consisted of both computer laboratory instructors and classroom teachers. Even though all taught mathematics, many of the teachers were not mathematics specialists, and their mathematics knowledge and skill were decidedly weaker, for their level, than that of the high school teachers. It was evident that, while reviewing software, these teachers availed themselves of the opportunity to learn and reinforce their mathematics knowledge and skill, often engaging the CIESE staff in lengthy mathematics review sessions.

Funding

In July 1989 partial funding for the 9th - 12th grade activities was received from the New Jersey Department of Higher Education Office of College-School Collaboration from Mathematics-Science Education Funds (Title II). The Bank Street College of Education joined the project at that time as an evaluator of overall project effectiveness, project organization, and college-school relations.

In the fall 1989 IBM awarded the project computer equipment and extensive software for two networked classrooms as part of a program to upgrade teacher preparedness in instructional computing. Each networked classroom consists of a PS/2 Model 80 file server and network controller, 15 PS/2 Model 30/286 workstations, and much of the mathematics and science software that forms the IBM Education Series.

Additional support was received in October 1989 from the U.S. Department of Education Program Fund for Innovation in Education (FIE) in partial support of the 9th - 12th grade program and expansion of project activities into the 7th and 8th grades.

Needs, Opportunities, and Barriers

Project activities are based upon the following premises:

1. the need to upgrade educational achievement of U.S. mathematics instruction (in an international assessment of mathematics and science education published in 1989 by Educational Testing Service (Martinez and Mead, 1988), American 13-year-olds performed most poorly among peers from five other countries),
2. the effectiveness of current instruction can be improved through the use of computer technology by teachers (U.S. Congress, Office of Technology Assessment, 1983 and 1988 and National Council of Teachers of Mathematics, 1989),
3. the low level of current computer use in mathematics instruction in U.S. schools (since initiating the Stevens Project in 1988, we found active computer integration in mathematics classes only in private schools in New York City and an occasional school in New Jersey), and
4. although many teachers are receptive to change, there are multiple barriers that thwart change in most school districts, and that these barriers may be overcome by a combination of internal commitment and expert outside intervention.

Potential improvement is not automatic; it matters how the technology is introduced and used. Becker (Becker, 1989) identified some characteristics for successful implementation, which include use of software that 1) provides unique capabilities (software, hardware, graphics) that are not otherwise available to teachers, 2) are used in context of an instructional plan that enables students to gain insight and understanding rather than simply obtain correct answers, and 3) engages the teacher in the intellectual analysis of the computer-based learning activities. Some of the reasons for little integration include:

- Few math departments can afford to buy computers for each teacher to use in their room.
- Teachers have to change lesson plans and teaching styles.
- Teachers are unfamiliar with software.
- Teachers have little time to develop, implement, evaluate, and revise changes in lesson plans.
- There are few successful, existing models of the use of computers in teaching mathematics.

At many middle schools and below, the problems are somewhat greater since the teachers may not only be uncomfortable with computers, but may not be well trained in mathematics.

Project Plan: Six Year Component Cycle at Three Levels

The Project is organized by grade levels into three components: separate on-going programs for 9th - 12th and 7th - 8th grade teachers, and the one proposed for 5th - 6th grade teachers for which funds are currently being sought.

Each of these components is planned in six year cycles, including five summer workshops.

- During the initial academic year, exploratory discussions are held between Stevens faculty and staff and the school system teachers and administrators at each of the five schools. These discussions determine topics for which the teachers would like to try to use computers. Stevens personnel then explore the software available for those topics and select and acquire those that appeared to address the needs expressed.
- During the first summer, in a 10-day workshop at Stevens, teachers from all the school systems have an opportunity to become familiar with hardware and software, and compare ideas and approaches. In 1989 each of the 29 teachers who attended received a $1000 stipend and expenses.
- In the second year, exploratory implementation of computer use and materials is initiated in consultation with Stevens faculty and staff.
- In the subsequent second summer workshop, teachers engage in extensive curriculum planning, preparing for more pervasive implementation during the third program year. These plans are documented in the form of lesson/topic plans authored by individuals or groups and distributed to all participants in the program.
- In the third year, teachers will try to use computers throughout the year whenever they consider it appropriate. Much of this use will be based on lesson plans written by other teachers in the program. Each teacher using such a lesson plan will be asked to suggest revisions, which will be communicated to the author of the lesson. After each time revisions are made, the lesson plan will be distributed

again to all the teachers in the program. It is expected that by the end of the third year over 100 lesson plan for the use of computers in teaching mathematics will have been written, classroom tested at least once, and revised.

- During the following summer, in the third workshop, a team of 10-12 teachers, at least one from each school, will develop publishable lesson plans, classroom materials, and guides for teacher use both at their schools and others.
- Materials testing and refinement continues for two more years, followed by the sixth year of active dissemination activities.

Evaluation

Formal project evaluation is being done by personnel from Educational Testing Service and The Bank Street College of Education. ETS is primarily concerned with educational growth of the students, impact of technology on the teachers, effect on the social structure of the schools, and the overall responsiveness of the projects activities to the needs of teachers. Bank Street will concentrate on the general organization and administration of the project. In addition, a student from the Princeton Sociology Department is studying the project for his doctoral dissertation.

It is premature to evaluate educational effects; so far we have collected pre-treatment test scores and measures of teacher attitude.

Much of the effect on students due to a project such as ours may be due to changes in teachers behavior. Teachers pedagogical styles as well as changes to the curriculum are being tracked, looking particularly for problems teachers must overcome, coping mechanisms, innovations, and teachers attitudes toward computers and innovation which affects and is affected by the project.

Introduction of computers in mathematics instruction may change the social structure of the school. Data on bureaucratic, administrative, and social actions by the various participants, both direct and indirect, is being collected.

Assessment of the roles and activities of the CIESE staff as intervening agents is being performed. Question of advantages and disadvantages of having university faculty acting as change agents and how to establish long term communication between college faculty and secondary school teachers are being considered.

Some results of the summer workshops can be communicated. Teachers reported that time was the most important resource provided to them. They used this time to evaluate software and plan lessons as they were expected, but they also reported that they had time to meet and discuss applications, logistics, and strategies with other teachers. They reported that this happens rarely, even within their own schools. Non-overlapping release periods and department meetings devoted to administrative issues preclude unhurried consultation with their own colleagues. They almost never get to meet teachers from other schools. At the workshops they could group around a computer to watch another teacher explore a program, which would inevitably lead to questions and then discussions. We provided breakfast and lunch on the same floor as the machines and the classrooms, so these discussions were allowed to continue even as the routine of the day progressed.

Teachers expressed their appreciation for being treated like professionals. They viewed everything, from being provided a stipend and food, as well as having their questions and suggestions being seriously considered by college faculty in their fields, to the workshop paradigm that they (the teachers) were the decision makers concerning software and lesson planning, as indices of being treated professionally by professionals. They complained about being constantly flooded with "experts" *telling* them what to do; they respected CIESE's openness to hear their needs and suggestions.

Project Rational and Merit

We believe the key factors for the success of the program so far include:

- Stevens faculty and staff role as collaborators and consultants. This non-directive approach has contributed to greater teacher self esteem and enhanced self-identification.
- On-going support services to school system administrators. They more readily invest in technology which they feel might otherwise receive limited use and/or have limited impact.
- Association of the priorities of a major science and engineering college with the importance of precollege mathematics and science education.

Given the rapid pace of hardware and software development and the distributed management of U.S. education among its 16,000 independent school districts, it is difficult to see how appropriate expertise can be brought to bear on the introduction of technology into the schools.

One promising model is the one we are following: to have faculty and staff at colleges and universities work closely with teachers and their entire school systems.

There are about three thousand colleges and universities in the United States and many have significant capacity for such action. This means there are about 5 or 6 school systems for each college and university, which is how many schools are in our project. What opportunities and barriers exist for colleges and universities to start such projects is the subject of another study.

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Appendix: Demographics of Collaborating School Systems

The five school systems involved in this project were selected to provide a variety of educational environments in which to create model programs. Although the schools vary in their current level of computer usage in mathematics course, each school does have a sufficient number of computers available to have begun the initial implementation phase of this project. Some possibly relevant statistics are give in the table.

School System	District Pop.	School Pop.	White	Black	Hispanic	Asian	SAT Verb	SAT Math
Bridgeton		1329	41%	48%	10%		397	445
Hoboken	42,000	1236	18%	9%	67%		308	346
WestSide	320,000	1438	7%	93%	3%	2%	312	354
Columbia	38,800	1664	73%	20%	4%	3%	436	497
Tenafly	15,000	842	76%	1%	1%	23%	comb.	1026

In Bridgeton 55 students are classified as "impaired". Less than 20% of the students enroll in four year colleges.

Most middle class students from Hoboken attend private schools. The resulting imbalance in the public school system has created a pressing interest on the part of school system administrators to recapture this middle class population.

West Side High School is one of 13 high schools in Newark, whose school district is the largest and one of the oldest school system in New Jersey and has severe social and economic problems.

Columbia High School is in the School District of South Orange and Maplewood; 85% of the graduating class of 1988 continued their education in degree-granting schools for higher learning.

Tenafly high school is in the Tenafly-Alpine school district; 84% of the Class of 1988 enrolled in 4 year colleges; 10.6% participated in the National Merit Scholarship Program; 11% enrolled in community colleges.

Tenafly is a suburban community, 4.4 square miles in area and located six miles northwest of New York City. It consists mainly of one-family homes. The combined Tenafly-Alpine population is about 15,000. Parents are highly educated, with 46% of the fathers and 24% of the mothers holding degrees beyond the B.A. Seventy-two percent of the fathers and 28% of the mothers are involved in professional and/or managerial occupations.

IMPLEMENTING AN ON-LINE INFORMATION "KNOWLEDGE NETWORK" IN MULTI-SITE LOCATIONS

James M. King and Mary Ann Hindes, The University of Georgia

Abstract

> *Knowledge is of two kinds; we know a subject ourselves, or we know where we can find information upon it.*
>
> Samuel Johnson (1709-1784)

Dr. Johnson would approve of the idea of a "knowledge network" or public access computing. Public access computing involves using a computer to access electronically stored information about a myriad of topics from a host of resources. An advantage of electronically stored information is that the data can be searched and retrieved from sites distant from the physical location of the stored information thereby allowing access to information at all hours of the day or night. John Sculley (1987), CEO of Apple Computer, dreams of a "Knowledge Navigator" designed to travel throughout the world's data banks retrieving information on demand in a brief span of time. Meeting Educational Needs Through On-line Research (MENTOR), is a step in realizing both Samuel Johnson's concept of knowledge acquisition and John Sculley's vision of the future.

What Is the MENTOR Project?

Meeting Educational Needs Through On-Line Research (MENTOR): A Computer-Based System for Knowledge Acquisition is a project funded by the U.S. Department of Education that provides the technology and training public and private school students need to access and use electronic information to prepare them to function in the high technology environments of college or the work place. MENTOR is equipping and interconnecting two public and one private high school, an elementary school, a regional public library and a large research university into an on-line research facility that will provide almost instantaneous access to information about millions of items in their combined collections. The MENTOR Project takes advantage of the graphical user interface capabilities of the Macintosh computer. MENTOR will make use of Compact Disc-Read Only Memory (CD-ROM) databases to provide access to dictionaries, encyclopedias, census data, comprehensive histories, scientific data, graphic and sound data from any school or library location. Through local school networks, students and teachers will work with computers in their classrooms to access their media center's on-line card catalog and CD-ROM databases. Through phone lines, students and teachers will be able to dial-up any of the other sites in the MENTOR Project to acquire additional information from their card catalogs or CD-ROM databases.

Rationale for the MENTOR Project

We live in an "information age" where instant access to data often means the difference between success and failure and sometimes between life and death. While business, industry and governing agencies have adapted quite well to accessing and using critical information through interconnected networks of databases, our schools, for all practical purposes, are still in the "stone age" of data acquisition. Classrooms and school libraries function much as they did fifty years ago. Students acquire information by searching volumes of print-based materials in the time honored traditions of scholars from the past. The problem is that our information bases have grown so numerous and massive that manual searches can be tedious and frustrating, and often inefficient and non-productive. Elementary and secondary school students need to be given access to and training in how to use electronic technology in the acquisition of knowledge if they are to succeed in our society of tomorrow.

Introduction

Futurists have predicted for a long time that society is moving toward an "Information Age." In many areas, such as business and commerce, the information age is an everyday reality. Businesses depend on instant information from far flung databases to make critical decisions which mean the difference between profit and loss. Our schools for all practical purposes have not entered the information age. Students still gather information using traditional search strategies involving the card catalog and discrete print indexes, a process that in no way emulates the current information retrieval practices used in business, industry and academic libraries. To graduate students from our secondary schools without an awareness of computer-based information resources and without the basic skills necessary to initiate a search, would be to short-change them.

How will schools fare with the new information technologies? Students in elementary and secondary schools constitute the largest population of library and information users with library media centers being the main access points for information in the schools. In the realm of technology, few innovations have captured educators as completely as the microcomputer, yet microcomputers are only slowly beginning to be used for information retrieval in school settings. Microcomputers allow for the dramatic changes that are taking place in the way information is distributed, accessed and mastered. As the information hub of the school, the library media center is the logical promoter of new technologies that can extend the amount of information available to students. The information contained on traditional catalog cards can be transferred to an on-line database creating what information specialists call an on-line public access catalog (OPAC). This on-line catalog can be accessed from classrooms within the school via direct link networking, or can be accessed from other locations through conventional telephone lines.

Compact Disc-Read Only Memory (CD-ROM) technology, which was introduced in early 1985, has important implications for schools. The advent of CD-ROM databases not only means vast amounts of information can be stored on a single disc, but offers a new way of searching through massive amounts of material. More than 250,000 pages of information or the equivalent of 1,500 floppy disks can be stored on a single compact disc. With a CD-ROM drive attached, a microcomputer is able to search, browse, and retrieve literally a modest library of books, journals and indexes. This technology has unveiled a new arena for potentially innovative applications, especially in education. In the past, few schools have subscribed to remote on-line services such as DIALOG because of budgeting problems. CD-ROM technology offers an alternative to expensive remote on-line searches. Information formerly available only by subscribing to remote on-line services can now be stored on a CD-ROM. Information is still considered on-line, but is not retrieved from a remote long distance service. Since many CD-ROM databases are updated quarterly, CD-ROM is a practical, cost-effective approach to providing current information. Students can use the CD-ROM without worrying about search time as a cost factor. The compact disc is an effective medium for high resolution graphic images, speeches, and animation, as well as for textual information. By combining the attributes of CD-ROM technology with the networking capabilities now available, electronically stored information will be available at all times in both the classroom and at home after school hours.

Purposes of the MENTOR Project

Objectives of the Project:

1) To introduce and instruct students in the use of new technologies and new ways of obtaining information. As a result of using the MENTOR System, students will learn the logical process required for accessing information electronically, thereby developing the research skills they will need in college or in the job market.
2) To provide educators and the general community with an information retrieval environment by providing a network model that emphasizes the idea of lifelong learning. A network that will effectively link the resources of the public school media centers, the public library, the university library and a private school's libraries, thereby making information available both during and after hours, is a logical extension of a rich informational environment. This cooperative effort will allow students and the entire community to have access to the holdings of all institutions involved.
3) To provide educators with evaluations of hardware and software (a prototype system) for implementing an on-line retrieval information system. By utilizing the resources of the Department of Instructional Technology and the expertise of its faculty, evaluation of the project will be an integral component throughout the implementation phases. The evaluation will focus on user friendliness, effectiveness, and cost-effectiveness.
4) To disseminate the findings through summer seminars for educators, presentations at national conventions, newsletter mailings and articles in educational journals.

Alvin Toffler (1970), author of *Future Shock* and The *Third Wave*, in commenting on the effects new technologies have on education stated, "If education has any function, any justification, it is to prepare young people for the future. If it prepares them for the wrong future, it cripples them." (Toffler, 1981). He would argue that the slogan" back to basics" should be revised to "forward to basics." Literacy is not confined to print in a world drenched in electronic communication. Preparing young people to function effectively in the emerging economy means foreshadowing what life will be like in the work force when these children are grown.

Developing the Full Potential of Students. MENTOR includes the placement of microcomputers in subject departments in the high schools involved (see Figure 1.). The students and teachers can access the holdings of the library media center or obtain information or full-text from CD-ROM databases as the need arises. Some refer to this as the "teachable moment." Skills needed in college and the job market can no longer be taught without the use of computerized information retrieval.

Provide Sound Tested Models for Improving Outcomes of Educational Systems. The literature concerning implementation of information retrieval environments in school settings is sparse. MENTOR is important because the evaluation of the system will provide information that can help other counties and states make decisions concerning information retrieval systems. The transferal of bibliographic information from catalog cards to computer databases is already taking place in many schools. To assure that this information is transferred in a form that can be networked with other schools and libraries and accessed from home microcomputers is of prime concern. Because of the cooperative nature of the project, assurances that the holdings of all libraries can be accessed is of utmost consideration. The pooled resources of public and private schools, as well as those of the public and university libraries, will provide a comprehensive network of available resources. Educators need knowledge and guidance in the purchase and implementation of programs. A goal of this project is to contribute to existing knowledge by addressing the problems inherent in implementing any system.

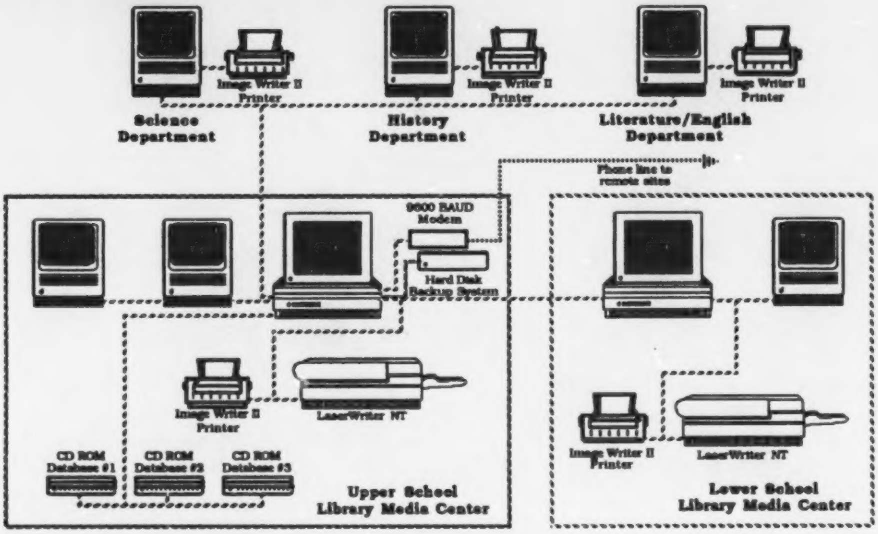


Image Writer II Printer
Image Writer II Printer
Image Writer II Printer
Science Department
History Department
Literature/English Department
Phone line to remote sites
9600 BAUD Modem
Hard Disk Backup System
Image Writer II Printer
LaserWriter NT
CD ROM Database #1
CD ROM Database #2
CD ROM Database #3
Upper School Library Media Center
Image Writer II Printer
LaserWriter NT
Lower School Library Media Center

Figure 1. Athens Academy MENTOR Site configuration.

Extent of Need for the Project

Needs Addressed by the Project: *Power On! New Tools for Teaching and Learning* (1988), a report from the Congressional Office of Technology Assessment (OTA), states that if technology is to realize its potential, attention should be focused on four closely related areas and that each area is affected by the others. The areas are:

- expanding the amount and capability of technology in schools to increase student access
- providing training and support for teachers
- supporting research, development, demonstration, and evaluation, with emphasis on ties between research and the classroom
- encouraging innovation and improvement in educational software

The first three needs are specifically addressed by MENTOR. The Office of Technology Assessment report also states that limited research results suggests that students using databases outperform other students in tests of information processing skills and in addition, teachers report that students using databases understand underlying concepts and relationships better, worked more cooperatively, and become more enthusiastic about gathering and analyzing data (*Power on!*, 1988).

How Needs Were Identified. The need for such a project as MENTOR can be established by witnessing the changes that have taken place in other areas of society. Business, the military, higher education, medicine, all have entered the age of information with great magnitude. A great chasm exists between what is possible and what is actually taking place in school settings. In the Public Broadcasting series, "The Day the Universe Changed: A Personal View by James Burke, " the major events in history that have shaped our civilization are presented. In one episode Burke describes the significance of Gutenberg's invention of the printing press and the impact it had on society as a mechanism to disseminate information. Burke believes that the computer as a technological force will have a much greater influence. He states, "We're about to bump up against a revolution that will make what Gutenberg did look like a quiet afternoon stroll" (Burke, 1985). The literature in general, substantiates the need for schools to provide experiences that will prepare students to live in an information society. Particularly noteworthy are the works of Daniel Bell (*The Coming of the Post-Industrial Society*), Alvin Toffler (*Future Shock* and the *Third Wave)*, and John Naisbitt (*Megatrends)*. Yet surveys, including one sent to media specialists in the state of Georgia, indicate that while many media specialists and educators would like to use microcomputers for a broad range of applications, including information retrieval, most feel inadequate about their knowledge and training. The need for training is clearly established. The University of Georgia has an on-line computerized catalog as do most large academic libraries. Commonly used indexes such as *ERIC*, *Psyclit*, *Dissertation Abstracts*, and *Newsbank* are now available in CD-ROM format and are being used in The University of Georgia library system. To exempt elementary and secondary schools from providing experiences that prepare students to use libraries other than their local school media center would be an abdication of responsibility.

How Needs are Being Met by the Project. MENTOR addresses the following needs:

- **expanding the amount and capability of technology in schools to increase student access** - MENTOR provides students with a computer-based system for searching the holdings of their individual libraries as well as the indexes and full-text information available on CD-ROMs. Students and teachers are able to access these same resources from selected classrooms. Students using the Athens Public Library in the evenings, will be able to access the information in any of the school sites. If one has access to a microcomputer at home, the databases of the libraries involved in the network can be accessed via a modem any hour of the day or night. The holdings of the University of Georgia Library are also accessible in this manner. This information-rich, easily accessible environment is expanding not only student access to information, but is doing the same for the entire community.
- **providing training and support for teachers** - MENTOR also addresses the need for providing training and support for educators. Two faculty members and a graduate assistant from the Department of Instructional Technology are working with media specialists and teachers during the installation phases, as well as during the training phases of the project.]Workshops for teachers and media specialists are planned so that MENTOR can be successfully integrated into the curriculum. Since the Department of Instructional Technology provides courses and workshops for media specialists throughout the state, another avenue for training exists.
- **supporting research, development, demonstration, and evaluation, with emphasis on ties between research and the classroom** - Research on the end-user of information retrieval systems has usually concentrated on college students. Research is needed on how elementary and secondary students interact and benefit from computer-based information retrieval. Tracking of student users through observations and interviews, in addition to quantitative measures of use, will be an important task during the evaluation phase. The locations involved in the project will inevitably be demonstration sites for those who are planning to implement their own systems. Visit and talk to installed sites" is a suggestion reiterated in the literature on information retrieval. Formative evaluation of the system, its reliability and its effectiveness, is taking place on a continual basis. A formal summative evaluation is planned at the end of the second year.
- **encouraging cooperation and the sharing of information resources** - The cooperative efforts of the institutions involved is providing the community with a richer information base from which to choose. With the increasing numbers of electronic CD-ROM databases, no one library can hope to purchase all the on-line databases that their patrons might request. By coordinating acquisition of these databases, MENTOR will facilitate the sharing of information resources, thereby encouraging cost-effectiveness.

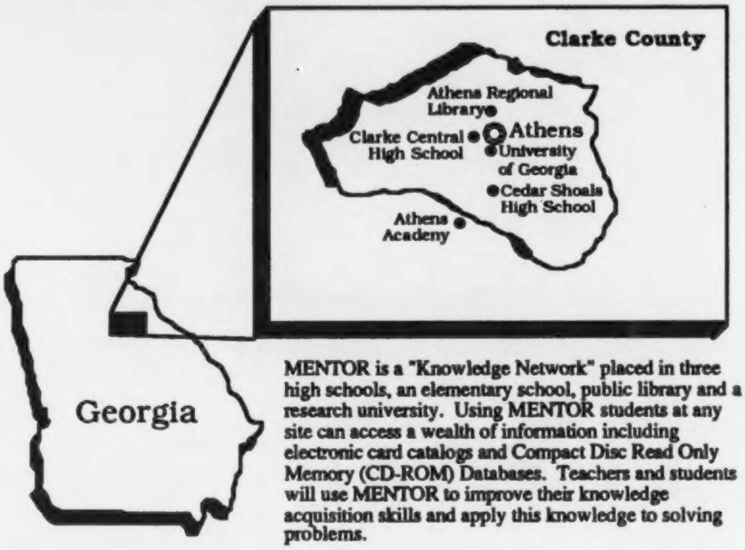
Benefits Gained by Meeting the Needs. Studies have indicated that ease of use is the single most important determining factor for the use of information. In a recent article in *Book Report*, the author (Pincock, 1989) describes what an instant hit a CD-ROM reference disc was with high school students"It represented a major leap from having to comb through seven volumes of *Readers' Guide* to a few minutes using the computer to search across five years of magazines. A similar search using printed sources would demand several hours and few students would have such tenacity. Most would have been satisfied with what they found in a single volume, without ever uncovering the article of a year or two ago that might have significant information for their project. For public schools to ignore the impact and societal changes that current technology has afforded would be unwise.

MENTOR is meeting the needs of an information hungry community. Through the use of multiple CD-ROM players and databases such as Grolier's *Electronic Encyclopedia*, Xiphias', *Time Table of History: Science & Innovation*, and Merriam-Webster's *Ninth New Collegiate Dictionary*, students are beginning to experience thrill of instant access of information. This is just the "tip of the iceberg" and the convenience of accessing these databases and others from the classroom or home is attractive.

There is another important benefit embedded in MENTOR. The lines of communication are being opened among the MENTOR Project Team members. Connecting the concerns of a private school, the public schools, the public library system and the College of Education's Department of Instructional Technology is indicative of community action in its best form.

Plan of Operation

Project Design. MENTOR is being conducted using the resources of two school systems, a regional library and The University of Georgia. The location of the study is Clarke County, situated in Northeast Georgia approximately 70 miles east of Atlanta (See Figure 2.). Clarke County with a population of 88,000, is the smallest county in physical size in Georgia. Athens, the county seat, is the home of The University of Georgia and many environmentally sound industries. The county has a consolidated school system with two high schools, three middle schools and ten elementary schools. In addition, there are three private schools, Athens Academy, Athens Christian and St. Joseph's Elementary. This area of Northeast Georgia is experiencing steady population growth and three additional elementary schools are presently under construction in Clarke County. In addition to the materials contained in the elementary and secondary school libraries, the Athens Regional Library and The University of Georgia Libraries provide excellent resources. The thrust of MENTOR is to provide easier and quicker access to resource information contained in these dispersed repositories. Through easier access, students are being encouraged to research projects more carefully and in greater detail, thus mastering the critical skills they will need to flourish in an information society.



MENTOR is a "Knowledge Network" placed in three high schools, an elementary school, public library and a research university. Using MENTOR students at any site can access a wealth of information including electronic card catalogs and Compact Disc Read Only Memory (CD-ROM) Databases. Teachers and students will use MENTOR to improve their knowledge acquisition skills and apply this knowledge to solving problems.

Figure 2. MENTOR "Knowledge Network Site Locations.

MENTOR is linking the libraries of Clarke Central High School, Cedar Shoals High School, Athens Academy Upper and Lower Schools, the Athens Regional Library and The University of Georgia. The decision was made to emphasize information retrieval at the high school level, although, Athens Academy Lower School has been included to test the feasibility of information access in the lower grades. The lower school also was selected because Athens Academy is situated in a campus-like environment with a number of classroom buildings dispersed over a five acre site. This beautiful, campus-like environment, while conducive to scholarship, sometimes restricts access to information from the upper or lower school libraries because of their separate locations.

Administration of the Project. MENTOR is scheduled to run for a two-year period. The management plan calls for a multi-track implementation process. During the first year, the CD-ROM databases have been selected and hardware installed at each site. Initial testing of the on-line CD-ROM database system is taking place in Clarke Central High School and University of Georgia sites prior to installation in the other locations. All sites have installed computer hardware and are working toward placing their library holdings into a computerized database. The conversion of the card catalog to an electronic database is being done commercially. The library media specialists in each school are working during the first year to make their "electronic card catalogs" fully operational. The implementation of a fully integrated library automation system which includes an on-line catalog, as well as capabilities for accomplishing the tasks of acquisition, circulation, inventory and cataloging, will take a year to accomplish. After the University site became operational, teachers and library media personnel from all schools involved in the project attended a one week training workshop to familiarize themselves with the system. During the workshop training, teachers were not only shown how to operate the hardware, but worked in teams with the project director and evaluation specialist to create student activities for integrating MENTOR into the curriculum. Teachers involved in this project included science, social studies and language arts faculty as well as library media specialists from the three high schools.

The second year will be spent evaluating the effectiveness of the on-line systems and making modifications necessary to facilitate the operations. Teachers will be encouraged to add additional activities that utilize MENTOR. All activities identified and used by teachers will be compiled into a handbook and operations guide to be used by future teachers and shared with other schools interested in adopting an on-line "knowledge network." This operations guide will be used as an integral part of workshops scheduled during the second year of operation. During the second year, two one-week workshops will be provided for media personnel from across the state of Georgia to familiarize them with MENTOR and to help them implement such systems in their home school districts.

At the end of the second year of MENTOR Project, all hardware and software will be turned over to the respective school systems with an agreement that MENTOR continue in operation and be expanded into additional schools as funds become available. Ongoing and yearly evaluations will track the success of MENTOR and hopefully such systems will become an integral part of the schools.

Evaluation Plan

Evaluation is an important aspect of the MENTOR Project. Both formative and summative evaluation techniques are being used to validate MENTOR's success. Although all hardware and software items used for MENTOR are "off the self" items, this is still a prototype system. Formative evaluation of the system has already resulted in the modification of automation and network software. MENTOR's operation and continuing evaluation will no doubt result in further changes to the "network." Both equipment and software logs are being maintained at each site for noting operational idiosyncrasies. In addition, a technical specialist is on call to assist with any operational problems.

Patron usage is also being closely monitored. Items to be evaluated include; levels of use, type of use, user friendliness of the system, teacher and student attitudes and teacher evaluation of the CD-ROM databases. Teachers are working closely with the library media personnel in evaluating the selected databases and in making recommendations for additional titles that can be placed on-line.

Appropriateness of Methods. The ultimate goal of a retrieval system is to bring about a desired change in the knowledge state of the user resulting from the content of the retrieved information. Therefore while the evaluation plan is concerned with the efficiency and reliability of MENTOR itself, concentration is being placed on the effectiveness of the system from the user's point of view. The following are a partial list of the criteria for evaluating the system performance:

1) utilization rate
2) users' studies
3) user satisfaction
4) retrieval effectiveness as measured by user feedback
5) effectiveness of end-user searching

Although qualitative performance criteria are not easily measurable, there are a number quantitative criteria that reflective the quality of service. Frequency data are a quantitative measure of system use that is indicative of the acceptance of the system by users.

Summary

MENTOR is a functioning prototype of the "knowledge network" that must be placed into our schools if we hope to keep pace with the growing mass of information in our society. MENTOR is teaching both students and teachers new ways to master information and use it to enhance research, learning and pleasure. We can no longer expect students to retain in "memory" all of the facts they need to know. Education must provide a student with the ability to find information and MENTOR is designed to meet this critical need.

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THE EMERGENCE OF THE EDUCATIONAL TECHNOLOGIST: A STANDARD FOR CERTIFICATION

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Abstract

This study will provide an analysis of the role of the educational technologist by examination of contemporary practice. From this analysis, a proposed set of standards for certification of educational technologists will be developed.

The study will provide answers to the research questions through the use of survey instruments directed to personnel in technologically advanced public school districts. Information will be sought requesting the identity of technologically advanced public school districts which currently have persons responsible for the promotion of educational technologies in the district curricula. States which have certificated persons performing the duties of educational technologists, or their equivalent, will be asked to forward their state certification requirements for the position. States which do not certify persons as educational technologists will be asked to present information regarding positions of an similar nature (such as instructional technologist).

The survey instrument will supply information which will be used to produce a set of guidelines for state agencies and teacher preparation institutions to certify educators as educational technologists.

Introduction

The introduction of new electronic technologies has changed the nature of instructional design and delivery (OTA, 1988). "The new technology is symbolized by computers, cable television, and satellite data communications" (Johnson, 1981, p. 15). Technological applications in education in recent years have been largely influenced by the proliferation of microcomputers in the schools as a new medium for delivering information (Mackay, 1988; Cimochowski 1984; Belland, 1982). Microcomputers, coupled with a variety of sophisticated audiovisual media, present challenges to those responsible for design and implementation of instruction. So called "convergent technologies" have created the need for a new breed of specialists with expertise in a variety of educational technology applications areas (Allen, Dodge, and Saba, 1989, p. 47). Accordingly, an educational technologist might be described as an educator who uses modern scientific methods and electronic instructional delivery systems to enhance teaching and learning. The name "educational technologist" implies most of the following special skills: curriculum construction; educational administration; design, production, and evaluation of instructional materials and/or programs; media utilization for education (i.e. television, computers, etc); library and information science; and select areas of psychology (i.e. cognitive psychology) and sociology (i.e. diffusion and adoption of innovations) (Hutchenson & Rankin 1989, p. 6; Berbeckar, 1986). Additionally, Waggoner and Goldberg (1986) recommend the technologist possess skills in instructional systems design.

Typically, the responsibilities for promoting the use of educational technologies in schools have been assigned to individuals filling dual roles such as mathematics and science teachers or library/media specialists who possess little or no formal background in educational technology but nonetheless are required to function in this capacity (Bratton and Silber, 1984; Kerr 1989). Teachers, need specialized skills in using modern electronic educational systems to function in the classroom both now and in the future (Kerr 1989).

According to a study conducted by Ernest (1982), educational media competence in teacher preparation programs has been made necessary by three basic forces:

1. the educational profession has been subjected to critical scrutiny by members of its own ranks as well as the public sector as emphasis on accountability and cost effectiveness has increased.
2. a rapid proliferation of technology has created an ever increasing array of tools and techniques of communication, entertainment, and instruction. Teachers must cope with students who are "media literates."
3. there have been myriad research studies conducted on the effectiveness of educational technology in the teaching/learning process(p. 2)

Content area teachers cannot reasonably be expected to keep up with the rapidly changing trends of modern information and educational technologies, as well as their own teaching areas (Belland, 1982). Assuming there is general agreement with most of the research described in the literature review, a distinct need emerges to assess the potential impact of educational technology with respect to the personnel responsible for its promotion in schools, and propose minimum standards for their certification.

Stahl (1986) described teacher certification as "the validation by a state board of education that a person has the required educational course work, experience, and professional characteristics deemed necessary to instruct in a given area" (p. 16). In order to certify educational technologists as professional educators, state and local education agencies must address the need for criteria consistent with established certification and staffing procedures (Galey and Grady, 1987).

The purpose of this study is to determine the duties and responsibilities most important for those personnel assigned to promote the use of educational technologies in technologically advanced public school districts, regardless of their position title, by incorporating the various recommendations found in the literature review.

The Problem

The literature indicates that educators responsible for the promotion of educational technologies in public schools have no set of standards on which to base their occupational duties and responsibilities. Furthermore, there are no states with regulations governing the school districts in this regard. School district personnel performing the duties of educational technologists, must be legitimized under the guidelines of a specialist's certificate or similar professional designation. The literature also points to a lack of uniformity with regard to the title assignments for practitioners in this area of expertise.

Need for the Study

The continued growth and development of educational technologies as well as their expanded use in the classroom, have created some potential problems for educators. Several areas of concern were identified in 1986 in documents published by the Association of Educational Communications and Technology (AECT) which outlined leadership imperatives for the educational technology profession. The AECT document described a distinct lack of proper descriptive terminology for practitioners in the field:

> ...there are too many names used to refer to our profession: educational media, instructional media, instructional technology, educational communications, instructional communications, learning resources, etc. These names are definitely confusing to people outside our profession. We must provide leadership by recommending a single terminology to designate who we are (AECT, 1986, p. 14)

The association further recommended that the profession develop "...clear standards for certification of its members." (p. 15)

This study will provide an analysis of the role of the educational technologist by examination of contemporary practice. From this analysis, a proposed set of standards for certification of educational technologists will be developed. It will be necessary to identify the duties and responsibilities of persons promoting the use of technologies in technologically advanced school districts, and compare and contrast their occupational activities with respect to the various titles assigned them.

Research Questions

The study will be guided by the following research questions:

1. What titles are used to describe the positions of persons who are responsible for promoting the use of educational technologies in selected technologically advanced public schools?
2. What are the occupational duties and responsibilities of the persons described above? Which of the duties and responsibilities are most common among them?
3. To what extent were practitioners' competencies obtained through:
   a. college/university for-credit courses
   b. inservice workshops, demonstrations
   c. on-the-job training/self help?
4. What state mandated certification standards are currently in place for persons described above? What elements are common among them?
5. What educational technology competencies are considered to be the most important in meeting the duties and responsibilities of respondents, performing the function of technologists in selected technologically advanced public school districts?
6. According to the respondents above, how frequently are content attributes, suggested in the literature, included in the competencies outlined above?
7. What educational and training qualifications do the respondents above consider to be essential in the preparation and certification of persons who serve as educational technologists?
8. How do the respondents' perceptions of critical competencies for serving as educational technologists compare with those found in the literature?
9. What competencies are recommended to provide a model for professional certification of the educational technologist?

Limitations of the Study

The need to review various areas of the educational technologies is necessary because of a lack of in-depth studies with regard to professional certification of persons functioning as educational technologists. Related areas such as computer certification, library/media specialist certification, and teacher preparation in general, will provide basis for this study. The study will therefore be limited to those issues which directly affect educational technology as it applies to professional certification of public educators.

The investigation will concern only school districts which have been identified in the literature as being exemplary in their efforts to integrate advanced learning technologies, including microcomputers, into school programs. Furthermore the methods of identifying such school districts may be flawed, and therefore districts which meet the minimum criteria identified in the literature may not be included in this study.

Because of the various names applied to the positions described herein, this study may have missed some individuals responsible for the promotion of educational technologies in selected technologically advanced public schools.

Competency items for the questionnaire were gathered from several studies mentioned in the literature review, and since some of the competencies pertain to technologies which may be considered obsolete, efforts made to ensure that additional competencies representing the newer technologies may have been short sighted in scope and therefore missed some important areas of concern.

Current Research

This review of the literature will identify pertinent information with respect to the competencies necessary for the performance of the duties and responsibilities of educational technologists. Findings considered important to the answering the research questions of this study will emanate from expert professional opinion and the most recent studies and surveys conducted at the local, state, and national levels across the United States.

The microcomputer will have a great deal of influence in future teacher certification practices and as such will be included in any discussion of certification of educational technologists (Galey, 1980). Furthermore, the trend toward greater use of non-print media in the classroom will ultimately result in increased emphasis on teacher preparation in these areas as well (Galey and Grady, 1987).

Diem (1982) pointed out that..."without adequate training and understanding there is little likelihood of most teachers augmenting instruction with technology no matter how attractive its usage may seem" (p. 3). For these reasons this study will also review teacher preparation program course content and inservice programs as they relate to technology use in the classroom.

Many of the studies used the Delphi technique to obtain consensus for the competencies listed in the questionnaires. The survey instrument question items generated for this study were formulated from this review and sent to the appropriate parties in state government and technologically advanced school districts.

Topic areas to be covered in this review include the following:

1. Teacher certification
2. Educational technology competencies
3. Computer technology competencies
4. Educational media competencies

Teacher Certification

Issues of teacher certification are handled differently by each state, but the basic premise of certification is that of societal approval and respect for the accomplishments of individuals who meet the qualifications for the certificate in question. While competence is the reason for certification to exist, there are two other vehicles for assurance of competence: accreditation and licensure.

According to Bratton and Hildebrand (1980):

> "...accreditation is the process whereby an agency or association grants public recognition to a school, college, university, or specialized study program that meets certain predetermined qualifications or standards." (p. 22).

With this kind of voluntary, self regulation, an institution will conduct a self study and then be visited by a team of professionals from the same area of expertise to conduct a type of 'audit' of the institution to determine whether or not it meets the goals of its charter as stated. Accreditation is only for institutions or their programs, not individuals.

Licensure "...is a mandatory legal requirement for certain professions in order to protect the public from incompetent practitioners." (p. 22) Individuals only are licensed, not the institution or employer.

Certification ..."is the process by which a professional organization or an independent external agency recognizes the competence of individual practitioners." (p. 22)

The authors point out that teacher certification is more of a licensing process since it is issued by a legal agency, the state government, and requires that all representatives possessing this credential shall have completed certain requirements prior to its issuance. Endorsements are added as necessary when the licensee desires to teach in specialized areas such as a computer specialist, or media specialist.

The literature indicates that the emphasis placed on the educational technologist's time, other than teaching, can be classified into three main competency categories with respect to educational applications: (1) educational technology applications (includes instructional design), (2) computer technology applications, and (3) audio-visual media applications. This review will present studies from both areas in an effort to describe the minimum competencies required by personnel working with these technologies.

Educational Technology Competencies

Ernest (1982) conducted a study to determine what educational technology competencies are most necessary for the preparation of new teachers at the preservice level. It also looked at a sample of teacher preparation programs to determine if there were curricular provisions set aside to include such competencies. The study posed the following questions:

1. What educational technology competencies for teachers are identified as most important by experts in the fields of media and teaching?
2. What educational technology competencies for teachers are identified as most important by personnel in a selected sample of teacher education programs?
3. What is the relationship between the competencies identified by the experts and the competencies identified by the personnel in the teacher education programs?
4. To what extent are the identified competencies taught in the selected sample of teacher education programs?
5. What is the relationship between the competencies identified by the experts and the extent to which the competencies are taught in the selected sample of teacher education programs (p. 7)?

This study was conducted using a modified, two round Delphi technique to identify competencies. The data was then used to provide basis for assessment.

The Delphi panel consisted of fifty experts in the media and/or teaching fields. Twenty media specialists from all over the United States, and ten each from the areas of teacher education, supervisory/administration, and classroom teaching, all from the state of Alabama. Members were selected according to their publication records, research or other application areas in educational technology. The final group was selected from an initial group of 100 by random process.

The study findings resulted in two basic conclusions: (1) media specialists, teacher educators, administrators, and teachers perceive educational technology competencies for teachers as highly important; and (2) graduates of the preservice preparation programs in Alabama have not utilized educational technology at the levels of importance established by the experts' and institutional representatives' perceptions (p. 19).

On a scale of 1.00 to 4.00, 64 of the 69 competencies had a mean of 3.00 or higher on round two. This placed the items in the moderately important to very important range. Interestingly, the five items below the 3.00 mark dealt with microcomputers, telecommunication/ computer developments, and photographic processes. Three quarters of the competencies were perceived as very important for preservice by Alabama teacher education program heads. Two of the microcomputer competencies listed were rated less than "moderately important" by the same group (p. 19)

Ernest discovered that preservice preparation was found to be at a lower level of importance than perceived"No category was taught in more than 44.6% of the institutions, and no single competency was taught in more than 57.1% of the institutions" (p. 19).

Kerr (1989) presented a paper to the Association for Educational Communications and Technology entitled: *Technology, Teachers, and the Search for School Reform.* This paper attempts outline the basic elements of reform necessary for teachers and educational technologists to realize maximum return on their efforts to include technology in the curriculum. Kerr reviewed the fields of teaching and educational technology from the points of view of the teachers and the technologists. Four elemental areas were presented: (1) preparation of models for teaching-with-technology; (2) design of intelligent software; (3) creation of technologically based tools to support teachers' professional work and development; and (4) improvement of research about technology in education (p. 5).

The educational technologist's vision of educational technology has seen the gradual trend away from emphasis on devices to a focus on systematic instructional design models and procedures along with a steady growth of interest in the cognitive and behavioral principles of learning, including artificial intelligence. Kerr points out that as a result of this approach by educational technologists, their activities have become increasingly distanced from the work of ordinary public school teachers. He suggested that there is general agreement among educational technologists that if teachers would incorporate instructional design practices, classroom experiences would be vastly improved.

> ...students would become motivated, instruction would become clear and logical, student achievement would increase, teachers would be freed from the drudgery of routine tasks, and classroom activities would become more varied(p. 7)

Kerr says, however, that teachers have been slow to respond, either to those who have encouraged them to use technology-as-hardware or those who advocate the use of instructional design as a possible solution to problems in education"The expectations and hopes of technologists have changed; reality, in the main, has not" (p. 7).

The teacher's vision of educational technology still, for the most part, implies hardware with its associated software, but not a process approach such as instructional design offers. Many teachers use simple technologies such as showing films or video tapes to get relief from the daily rigors of the classroom setting. Often, the use of films or tapes may bring on new ideas or alternative points of view just from seeing how the rest of the world operates.

According to Kerr, if teachers did want to pursue the educational technologies from the standpoint of development, other than the application of hardware and software, they would have little or no time to spend because of the constraints placed on them by administrative maintenance. Furthermore, "teachers are not provided with or taught how to use more helpful alternative models during teacher training" (p. 9).

The technologist's view of teaching gives the impression that teacher's roles in education ..."is something to be refined and shaped by principles of instructional design: inconsistencies are to be smoothed out, digressions eliminated, predictability developed" (p. 10). Instruction, according to the technologist, should be designed in a manner that minimizes the contribution of the teacher and, in some cases, eliminate the instructor altogether.

The teacher's view of teaching changes rapidly during their early exposure to the task. Teachers, once they make it through their first year or two, begin to formulate their ideas about what it is they should be doing (and how) including the construction of their classroom "world" which ultimately reflects their concept of what teaching entails. Kerr points out that teachers find comfort and solace in their classrooms in helping to overcome feelings of isolation from their peers. They often resent outside interference in their classroom affairs, and consider most administrative requests to be an unnecessary burden on their already demanding schedules. Teachers' descriptions of their occupation tends to direct attention to conventional "wisdom of practice" and the need to develop and maintain individual interactions with their students. Kerr states that teachers ..."see the barriers to improvement of schools as lying largely in administrative realms and express their frustration with not being allowed to have more control over their own destinies" (p. 8).

Educational reform, according to Kerr, presents new challenges to both teachers and educational technologists to stem the tide of decline in academic standards and lack of confidence in public education. He cites the Teachers College Record article by Joseph McDonald who described the current "second wave" of reform as the search for "the teacher's voice" (p. 9). The major goals are:

1. Democratize school administration. This will allow teachers to take certain leadership responsibilities in an effort to direct their own school's destiny
2. Enhance teacher professionalism. Allow teachers the ability to select curricula, instructional materials, and teaching methods; make decisions on research, peer evaluation, merit promotions, and professional development.
3. Alter teacher and student roles. Shift roles to allow the teacher to become a guide or coach instead of the source of knowledge, diversify classroom activities to reduce frontal orientation of instruction, and introduce a variety of instructional models and practices.
4. Conduct new kinds of research on teaching and teacher preparation. Attempt to have colleges work more closely with teachers in defining what teacher preparation courses should cover in their curriculum.

Educational technology can do its part in educational reform by developing teaching-with-technology models, designing supporting software, supporting the education and future professional growth of teachers, and improving research on teaching-with-technology (p. 11-13).

A Delphi study entitled, *Preparing Schools for the Year 2000*, (1988), conducted in cooperation with the Association for Childhood Education International, surveyed the attitudes and opinions of specialists on the use of educational technologies in their curricula for the foreseeable future. The group was asked to prognosticate the use of technologies in the K-9 classrooms of the future. In addition, they were asked to forecast how curricula might change as well as instructional materials designs in the coming years.

This Delphi study started with an open ended set of questions in order to elicit a wide response. Three basic questions were asked of the respondents:

1. In reviewing the K-9 curriculum, what are the top five skills and/or subjects that are likely to be emphasized in the next ten years?
2. What types of instructional materials will be essential in the classroom and in the school media center in the mid-90's?
3. In what ways will classroom teachers use new technology as a teaching tool in the mid-90's? (p. 1)

The seventy eight participants consisted of classroom teachers, school and college level library/media faculty or specialists, school administrators, state education representatives, educational consultants, and national education organization personnel (ERIC, NCLIS). Twenty-seven states from all regions of the United States were involved.

The results found professionals in general agreement that "today's students must be educated to face a world that is becoming increasingly complex: a highly technical and information-oriented society where individuals must absorb an explosion of information as well as new theories and discoveries. The rapid advance of computer technology has fueled this process, making vast amounts of information available to those who have learned to use a computer" (p. 3).

Further comments pointed out the increasing dependence on technology to carry out even simple life skills and how students "must be prepared to manage and control it." The world was described as "fast moving, constantly shrinking" and "influenced by a variety of cultures that we don't know very well" (p. 3). Important on the list of skills to be developed by students are things such as comprehension, communications,and cooperation. Furthermore, coping skills to deal with the myriad of social problems in today's society were given high priority by respondents along with a need to become literate, critical thinkers.

The classroom of the year 2000 will look like a high-tech living room complete with televisions, VCR's and computer gear interconnected to videodisc players and CD-ROM drives and satellite receivers to provide maximum access to a wide variety of multimedia experiences for students. An educational consultant remarked that, "Technology will help bring the world much closer to all classrooms. The learning environment will not be the classroom, but the world" (p. 4).

The curriculum in the year 2000 is expected to contain such important skill requirements as listening, speaking, reading, and writing in the language arts; problem solving in math and science; social skills and personal fitness in health and physical education; literature and art appreciation in the humanities and arts; and geography and history and world cultures in the social studies.

Finally, teachers need a whole new set of applications skills to develop new attitudes toward use of technology in the classroom of the year 2000.

Computer Technology Competencies

Cimochowski (1984) conducted a study to examine levels of preservice and inservice teacher preparation in computer education at member institutions of the American Association of Colleges for Teacher Education (AACTE). The study investigated: (1) what is being taught in introductory courses; (2) which of the departments/schools are teaching computer education courses; (3) how many courses are being offered for preservice and inservice teachers; (4) qualifications of the professors teaching the courses; (5) number of students enrolled in the courses; (6) time preservice and inservice teachers spend using computers and; (7) relationship between computer education courses offered and size of the teacher education program, public or private school affiliation, and regional location of the AACTE member institutions (p. 1).

Findings indicated that there are a number of questions which remain to be answered:

1. What can be done to implement computer education course work at institutions where no such programs exist, to broaden the scope of those programs which do exist, and to make both preservice and inservice teachers aware of what teacher training institutions offer in computer education?
2. What can be done to increase the number of teacher training programs that require computer education course work for graduation? (p. 3)

Solutions to the problems outlined above are multifaceted and complex, but they are forthcoming by way of research studies. Suggestions made by the authors are indicative of such inquiry:

1. Identify those institutions that have exemplary teacher education programs in computer education. Then, once identified, a listing can be circulated through national organizations with widespread distribution networks on a regular basis. The dissemination of this information at the national and state levels "...would be of great value to teacher training institutions as well as prospective teachers and inservice teachers." (p. 4)
2. The requirement for computer education course work in teacher training programs may revolve around a state education agency (SEA) policy issue since most state departments of education set teaching certification standards. In reports by the Education Commission of the United States (1983) only a small number of states have set a computer literacy requirement for high school graduation and even fewer (the District of Colombia, North Dakota, and Virginia) are requiring teachers to have course work in computer education. However, another thirty states are studying the teacher certification requirements and/or recommending computer education training for teachers.

The author further recommends that this type of investigation be conducted on a regular basis as a follow-up using similar questions with revisions as necessary. She feels that it would be valuable to ask about such things as upper level course offerings, and include a description of each to determine course coverage and content, number of credits. Additional information could be items such as which courses are required, course time spent on computer related activities both in and out of class, etc.

Chen (1984) conducted a Delphi study on computer related competencies needed by secondary teachers in Taiwan. This study was conducted to identify a list of competencies needed by teachers through the year 2000, and to determine differences in the assigned importance of these competencies by the respondents involved. The Delphi approach was used because there was little data available related to the minimum computer related competencies needed be the secondary school teachers of Taiwan.

Chen surveyed secondary school principals and teachers, teacher educators, and experts from government and industry from various geographical locations across Taiwan. The results were rank ordered as follows:

1. Possess ability to solve simple computer related problems.
2. Have a thorough understanding of the application of the computer to motivate student learning.
3. Possess ability to effectively utilize the computer as an instructional aid.

4. Understand the influence of the computer, its impact on modern society, and its future trends.
5. Possess ability to operate at least one commercial microcomputer or personal computer in school or at home.
6. Possess skills in using instructional packages.
7. Have knowledge of computer assisted instruction (CAI), its meaning and function.
8. Possess ability regarding the application of the computer to input/edit/output test from test inventory.
9. Have ability to motivate students' interest in studying computer science and to apply computer concepts creatively to a variety of applications. (p. 99)

Conclusions reached as a result of this study were as follows:

1. The competency statements show that the panel members are very optimistic, future oriented, and aware of the problems teacher education programs will have in incorporating computer technologies in their courses.
2. The competency statements range from the basics, such as use of the computer, to newer issues of automation and artificial intelligence.
3. It was the consensus that competencies as presented represented the majority of expert opinion.
4. Secondary principals and teachers placed the most items in the agree or strongly agree category, indicating their desire to see these items become part of professional education courses.
5. Government and industry experts as well as teacher educators perceived more competencies in the 'disagree' or 'strongly disagree' levels than principals or teachers. It is believed that this is a result of their concept of need with regard to the competencies identified in the study being different than the other respondents.

Among the final recommendations of this study was one suggesting that ..."many competencies are beyond the basic levels needed by all secondary school teachers, but should be possessed by at least one teacher on every campus" (p. 120). A further suggestion included having an office of computer education in each school to facilitate computer use by teachers. Office duties would include:

1. Supervising computer laboratories
2. Assist in developing scope and sequence of computer education at the school
3. Set up equipment for use by faculty and staff
4. Train faculty and staff in selection and use of software
5. Troubleshoot hardware and software problems
6. Coordinate repair of equipment

Other recommendations of this study pointed out some barriers to computer literacy training of teachers:

1. The traditional focus of teacher education programs
2. Lack of instructional computer facilities
3. Lack of competent teaching staff

Some respondents pointed out that..."the lack of knowledge and support from administrative staff were the largest obstacles preventing the use of computers in schools" (p. 121). It was suggested that computer literacy be extended to administrators, and teachers through continuing education, inservice workshops, and graduate credit courses.

Audio-Visual Media Competencies

Savenye (1989) conducted a study to determine what teachers need to know in order to use technology effectively in the classroom. The study was done in an attempt to improve the content of a one credit media competency course required of teachers in order to receive their credentials in the state of California. The course provides teachers with the opportunity to apply the principles of instructional systems design according to "...Gagné's (1977) nine events of instruction; media equipment operation; production of dittos; overhead transparencies and laminated visuals; media selection; basic instructional video production; and an introduction to educational computer software evaluation" (p. 3).

Survey questions were asked to determine both present and future needs of teachers for technology use in the curriculum. Areas of coverage were as follows:

1. Entry level technology skills of teacher credential candidates: What instructional materials have they produced? What devices can they operate?
2. Final evaluations of the skills they learned in the media course by students finishing the course: What do credential students perceive as the most, and least valuable skills they learned?
3. Perceived needs of new teachers in the field: What technology related skills, learned during their credential programs, do they feel help them teach most effectively?
4. Perceptions of teacher education leaders: What do teacher educators believe teachers should learn in order to teach effectively using technology? (p. 3)

The results show that teachers, both preservice and inservice, believe that learning about commonly available materials and equipment is important. Such items as overhead transparencies, dittos, chalkboards, and using projectors of all kinds were included in their opinions. It seems, however, that knowledge of most of these items was already possessed before the media course began, and that valuable class time could have been spent learning about newer, more distant technologies such as video production and media selection. Teachers felt that things already known could be applied to lesson preparation techniques in methods courses. Further recommendations were to increase emphasis on items such as video production, computer related activities including CAI, interactive video, CMI, CD-ROM, and telecommunications.

In summation, the author concluded that: "with the great need for teachers who are adept at performing the multiple roles required of them when they use the power of technology in their classrooms, can provide an opportunity for teachers to become 'empowered' themselves. This study indicates that preservice and inservice teachers recognize the dual need to be skilled at basic media use, while preparing themselves to skillfully use the new technologies to enhance their students' learning" (p. 8)

McCutcheon (1984) conducted a study to determine the factors influencing the content of introductory media courses offered in undergraduate teacher education courses in the United States. The two major areas of investigation were (1) the topic coverage in the courses and (2) the perceptions of the course instructors as to how such topics are determined. It was discovered that, for the most part, the course instructors themselves were largely responsible for course content with contributing factors such as: college or department policy, student expression of needs, state certification requirements, items reported in the literature, and textbooks playing a lesser role.

McCutcheon points out that ..."the importance of introductory educational media courses to the professional community offering them cannot be disputed. Such courses provide an overview of the instructional technology field and by so doing, serve the function of recruitment both into additional courses and possibly into careers" (p. 10). The introductory course serves as the largest employer of teachers in instructional technology. These teachers in turn add their expertise to further course development add the study of new technologies to their course outlines as they become viable for curriculum integration.

The media course content items are among the items listed as important in a number of other studies cited in the literature. Some studies date back to the 1930's and contain some competencies that are truly futuristic for the times. An example is the mention of a study by Starnes in 1937 which describes as one of its competencies "radio and television education" (p. 32). Current studies have added more modern devices to the study of educational technology as computers, video discs, CD-ROM, interactive video, and satellite telecommunications systems.

Methodology

The study will provide answers to the research questions through the use of survey instruments directed to personnel in technologically advanced public school districts and teacher preparation institutions which have educational technology programs. The districts in question will be identified using criteria established by Sonier (1989) as well as the state departments of education. Information will be sought requesting the identity of technologically advanced public school districts which currently have educational technologists or their equivalent in place. Those states which have certified persons performing the duties of educational technologists, or their equivalent, will be asked to forward a copy of their state certification requirements for the position. States which do not certify persons as educational technologists will be asked to present information regarding positions of an similar nature (such as instructional technologist).

Population

Each state department of education will be asked to supply the names of two school districts who they identify as exemplary districts with regard to the application of advanced technologies to their curricula. Further identification of districts will be done according to the following criteria presented in the literature (Sonier, 1989):

1. The district has been cited by popular literature as being innovative in the integration of microcomputers and other technologies in school instruction.
2. Evidence of planning, adequate funding, and staff/community participation is cited in the literature review.
3. The literature citation of the school district's technological accomplishments appears in a publication specializing in educational research and/or technology(p. 41)

Once the districts have been identified, it will be necessary to determine the name(s) of those who are performing the tasks of the educational technologist or whose occupational title most closely compares with that of educational technologist as outlined in the literature.

Gathering Data

The survey instrument will be sent to the contact persons in those school districts identified as technologically advanced. Demographic information will be requested as part of the questionnaire to establish background for the study. In addition, the respondents will be asked to indicate which of the (number) competency areas is currently part of their position responsibilities, and the extent to which they perceive the value of the area in question.

The Instrument

The instrument will be developed based on findings from the literature as well as information gathered from state departments of education which have certification for educational technology related occupations. Competency items for the questionnaire were gathered from several of the studies mentioned in the literature review. The competencies in those studies are understandably dated and therefore every effort was made to ensure that additional questions representing the newer technologies were included. If there are items which the respondents feel are important but have been omitted, there will be blank space for them to write in additional competency areas as needed.

A Likert scale format will be used to facilitate timely completion with a pilot version being distributed locally to test validity. This pilot version will be administered to all ten school districts in Northampton County, Pennsylvania, to assess their perceptions of the educational technologist's duties and responsibilities. Comparisons will be made between the pilot and the actual descriptions provided by the literature and the certifying states to determine need for revisions.

Analysis of Data

The demographic information will be analyzed to indicate the following:

1. percent of position titles
2. percent of years of experience
3. percent of highest degree attained
4. percent of major and minor study fields
5. percent of credit or non-credit (inservice) courses

Each of the (number) competency areas will be analyzed for the following:

1. The frequency of respondents affirming the presence of a particular competency area necessary for their present occupation.
2. The average of the importance "value index" assessments placed on a particular competency area.
3. The percentage of content attributes present in the respondent's competency area necessary for their occupation.
4. Pattern of response for each competency area with respect to the respondent's position title.

Survey results will be reported for each competency area. Results of reported competency area occurrence as well as the frequency of perceived competency area content attributes will be reported as raw scores and percentages.

Questions assessing the necessity of a competence area, when present in the respondent's occupational responsibilities, will be in a Likert scale format. A numerical value will be assigned to each response, for example: a value of 5 will be assigned to indicate that the competency area is of "great importance", 3 to "some importance", 1 to "no importance". These results will be averaged and labeled as the "importance value index".

Competency areas reported as important for over two-thirds of the respondents will be recommended for consideration by state certification officials in the generation of a certificate classification. A rank order listing of the competency areas most frequently addressed by the respondents will be delineated in table form. How important these areas are perceived to be will be reported to provide certification competencies for the state agencies. Sample occupation description documents, collected from the exemplary school districts, will be examined for the presence of content attributes identified in the literature. This analysis will help verify the accuracy of the respondents' perceptions of their district function for the position they occupy, and identify exemplary occupational competencies.

The second part of the instrument will present criteria of the educational technologist's position description as determined by the literature review and certifying state criteria. The respondents will indicate the appropriateness or inappropriateness of certification attributes based on his or her perceptions of their present occupation or function. Responses to the questions will be in the form of a Likert scale. Two sets of questions will be developed from the initial questions below. The pilot set of questions will be distributed to the appropriate persons in the Northampton County school district in Pennsylvania to determine validity. The participants' answers will determine the content of the final set of questions.

Discussion

This study will be conducted over the next six months, and results will be reported shortly thereafter. It is important to realize that the field of educational technology is in a state of continuous flux and any investigation of this kind must be ongoing. The competencies determined to be most important this year will undoubtedly take on a different level of emphasis next year. Most of all, this kind of effort is important from the standpoint of professionalization both for the educator and the certifying agencies preparing them. It is hoped the results of this study will pave the way for the establishment of standards with which the profession can claim its rightful place in the world of educational excellence.

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Selected Formal Papers from the

Special Interest Group for Emerging Technologies (SIGET)

USING EXPERT SYSTEMS APPROACHES TO SOLVE MEDIA SELECTION PROBLEM: MATRIX FORMAT

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Media selection has been identified as an integral part of the total instructional development process in many instructional design and development models(Anderson, 1983; Gagné, 1988; Briggs, 1981; Boucher, 1973; Sleeman, 1979). However, the selection of efficient and effective media "is complex and difficult because it is based upon a combination of interrelated factors", (Anderson, 1983 P. 1).

Many systems have been developed to help instructional designers select media. The problem with these systems is that they may overwhelm the instructional designers with the quantity of information they produce. This is important because many courses must be designed by instructional designers in as little as three to twelve months. Complicated manual systems may not be usable for instructional designers under these severe time constraints. The instructional developers simply do not have the time to run through complicated flowcharts, matrices, or worksheets.

Three additional problems with paper-based media selection models are that they do not reference high technology media, present viable and thorough media selection factors, and do not reflect the knowledge of multiple media specialists.

The complexity of the manual media selection models and the consistency of many of the media selection factors suggest that a MSES could be developed to improve the entire process. Such an expert system would assist instructional designers in making quality, and timely decisions. This research project was designed to address these two issues by developing and evaluating a Media Selection Expert System (MSES).

The Problems and Its Setting

According to media experts, media selection decisions should be based upon the instructional setting, learner characteristics, instructional events, learning outcomes , physical features and practical factors (Reiser and Gagné, 1983; p. 15). Unfortunately, instructional designers may not be media specialists and hence not aware of many of the factors needing to be considered during media selection. Thus, it is often difficult for instructional designers to make the appropriate media selection decision. Furthermore, assistance during the media selection process is often difficult to find.

Most media selection models don't include high technology media. For example, Intelligent Tutoring Systems, Digital Video Interactive, and Compact Disc Interactive were not included in any of the fifteen media selection models located during a literature review of media selection procedures. Most models also do not justify the specific media and media selection factors (attributes) that they reference, (e. g. Briggs, 1981; Romiszowski, 1988; Boucher, 1973)

The format for the display of media selection models can be categorized into flowcharts, matrices, and worksheets. Most of the media selection expert systems available today use the flowchart approach to develop a rule based expert system. The flowchart procedure leads to a progressive narrowing of media alternatives. Questions about media selection are posed in a particular order, and as each is answered, the number of candidate media is reduced. Typically, flowchart models produce a small set of recommended media.

Although the flowchart format is usually simpler to use, the approach may be criticized because the questions and their sequence is usually based on only one human expert's knowledge. Thus the flowchart format is subject to the problems of personal bias and the limitations of individual knowledge. In contrast, the matrix approach allows the knowledge of a group of human experts to be easily stored and lets the user choose media based on the experience of more than one expert. The MSES's knowledge base was constructed in a matrix format because of these considerations.

Purpose of the Research

The purpose of this research is to develop and evaluate a media selection expert system that will address all of the above problems that are embedded in current media selection models. The expert system should assist instructors and instructional designers in making consistent and systematic decisions based on the nature of the learning task.

Importance of The Research

Richard Clarke (1983, 1985), has come to the conclusion that "no media, in their own right, have any influence on learning effectiveness, but are mere 'vehicles' for more, or less, well designed instruction". But, vehicles vary in the pleasure they provide and in their efficiency. Questions such as, "Is the medium capable of presenting the instructional stimuli required for learning?" and "Can it arrange for the students to engage in the required learning activity?" are worth being investigated to identify the most appropriate media.

Educators and trainers throughout the world are trying to choose appropriate media for particular instructional situations. Today's emphasis on effectiveness (cost or learning outcome) make the role of media increasingly important to the total instructional program. The needs of adult education and officer training provided an excellent opportunity to study media selection for those courseware development.

Expert System Development

The value of the subset of AI, known as expert systems, is that it can be implemented on desk-top microcomputers and may play a significant role in instruction and training. Expert systems can be defined (Feigenbaum, 1984) has defined an expert system program as "an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solution. The knowledge necessary to perform at such a level, plus the inference procedures used, can be thought of as a model of the expertise of the best practitioners of the fields".

The construction of the MSES followed a four-stage process in order to capture the essential tasks involved in building a media selection expert system.

Stage 1. Problem Identification and Resource Assessment: This stage addresses the suitability of the proposed problem and whether the developer has the resources to be successful with the project. Media selection was identified as a suitable problem for the following reasons.

First, media selection is complicated and requires a high level of human expertise to solve it. Second, the problem domain is relatively narrow. Identifying appropriate media selection attributes and media to include in the expert system were identified as the critical issues. This was accomplished by thoroughly reviewing the literature describing existing media selection models and by consulting with human experts. Third, the knowledge of human experts could be acquired by survey and could be easily represented in numeric form in a knowledge base (Matrix format).

Stage 2. Programming language or Expert System tool selection: This stage determined whether an Expert System shell or a programming language was most appropriate to support the Expert System. Identifying the approach used to develop the expert system requires the consideration of factors such as in-house expertise, budgetary limitations, time, and problem domain. The VP-Expert shell was selected to for the media selection expert system on the basis of the the following reasons.

First, VP-Expert is primarily a rule-based expert system tool. Its domain control mechanism is backward-chaining with limited forward-chaining and its induction feature that can generate rules from data. The tool's capability is suitable to solve the media selection problem because of the relatively narrow media selection problem domain.

MSES MEDIA POOL

1. COMPUTER:
   - CBT (Mainframe or PC)
   - CD-ROM
   - Computer Interactive Videodisc
   - Digital Video Interactive
   - Compact Disc Interactive
   - Expert System
   - Computer Simulation
   - Computer Game
   - Teletext / Videotext
   - Intelligent Tutoring System
2. MOTION IMAGE:
   - Video Disc (Cassette)
   - Motion Picture
   - Broadcast Television
   - Teleconference / Videoconference
3. PROJECTED STILL VISUALS:
   - Slide
   - Overhead Projector
4. GRAPHIC MATERIALS:
   - Workbooks
   - Printed Job-Aids
   - Visual Display
5. AUDIO:
   - Tape/Cassette/Record
   - Teleconference/Audioconference
6. TRAINING DEVICE:
   - Real Object
   - Model
   - Training Device
7. MULTI-MEDIA:
   - Slide / Tape
   - Print / Picture / Tape
   - Multi Image System
8. Tradition:
   - Mediated Interactive Lecture

Figure 1. MSES Media Pool

MSES MEDIA SELECTION ATTRIBUTES

1. INSTRUCTIONAL SETTING:
Effective for Multi-Site
Individualizing Instruction
Effective for small size group use
Effective for medium size group use
Effective for large size group use

2. LEARNER CHARACTERISTICS:
Effective for Older Learners
Effective for Poor Readers

3. LEARNING OUTCOMES:
Effective for Learning Facts
Effective for Learning Categories
Effective for Learning Procedures
Effective for Learning Rules
Effective for Learning Principles
Effective for Learning Psychomotor Skills

4. INSTRUCTIONAL EVENTS:
Informing Learners about the Objectives
Presenting Stimulus Materials
Supporting Practice to Obtain Mastery
Providing Feedback
Assessing Performance
Effective for Interaction
Effective for Self Selection
Effective for Self Pacing
Accepting Overt Response
Showing Time Lapse
Recording Student Performance
Information Storage and Retrieval
Effective for Group Interaction

5. PHYSICAL FACTORS:
Visual Requirements
Aural Requirements
Presenting Motion
Presenting Color
Presenting Body Cues

Figure 2. MSES Media Selection Attributes

Second, VP Expert allows developers to link together many smaller knowledge base, which, if combined in one big knowledge base, might exceed memory capability. This is made possible because VP-Expert supports three kinds of integration: DOS execution calls, Spreadsheet access, Database manipulation.

Third, VP Expert's input and output features allow users to interact easily with the program. In addition, the hypertext facility allows the developer to easily create on-line help utilities for the users.

The Media Selection expert system utilized many of the facilities available through VP Expert. The program was integrated with the PC-Pilot Authoring program, PC-Paintbrush graphics, and Turbo Pascal to improve its overall performance.

Stage 3. Prototype Expert System Development: This stage addresses issues relating to knowledge acquisition, knowledge representation in the expert system, user interface development, explanation of the system's reasoning, and management uncertainty.

After reviewing media selection models and consulting with human experts, thirty media were identified and categorized into eight categories. The MSES media pool is presented in Figure 1. Thirty-one media attributes were identified and categorized into five media selection categories.The MSES media selection attributes are listed in Figure 2. A survey was constructed to acquire knowledge from nineteen media specialists who were in either the U.S. Army training division or academic environments. The survey responses were statistically analyzed and the knowledge was represented in a matrix format with thirty media across thirty-one training effectiveness attributes.

In summary, the MSES knowledge base was gathered directly from published research and the experience of many media specialists. This expertise has been stored concisely in a matrix knowledge base and reasoning in a matter of only a few seconds for each and every objective in a course. Hypertext files were used to present on-line help, and the system uses a mouse and keyboard to allow users to interact with the Expert System.

Stage 4. Testing, Evaluation, and Maintenance: The final stage of the development of the media selection expert system involved estimating the quality of the ES. This involves a system evaluation to determine the level of expertise and accuracy that can be expected from the MSES. There were three different approaches followed for the system evaluation: verification, validation, and user acceptance. Human media selection experts and typical users participated in the evaluation of the MSES.

Verification refers to determining whether or not the knowledge base and inference engine that drives the system is correct. Verification primarily requires the domain experts to determine the correctness of the knowledge base because inference engines are thought tested by the manufacturer. The verification data analyses demonstrated agreement across the 19 human experts in their understanding of the relationship between the media and the media selection attributes.

Validation refers to determining if the system's advice is adequate and at an acceptable level of accuracy. Six instructional objectives were developed and were categorized according to Gagne's categories of learning outcomes. For six instructional objectives, media recommendations generated by MSES were compared to media recommendations produced by media specialists and target users. Subjective judgements were used to determine the quality of the advice given by the system. A judgement group, consisting of five experts, was used to evaluate the quality of the recommendations of the media specialists, target users, and MSES. The conclusions of MSES validation are presented in the following:

1. Instructional designers without the MSES have a .62 acceptance value.
2. Instructional designers with the MSES have a .71 acceptance value.
3. Media specialists working alone have about a .67 acceptance value.
4. Media specialists working with MSES have about a .71 acceptance value.
5. Instructional designers performance is improved .15 by using the MSES !!!
6. The MSES knowledge base was gathered directly from media selection models ,current published research and from the experience of nineteen responding media specialists. MSES provides the instructional designer an inexpensive consultant whose consistent, automated decisions and recommendations had shown significant improvement on instructional designers' decision making.

User acceptance was included in the evaluation because some expert system applications are not used in spite of the fact that they function properly. This occurs when the target users do not like using the system. Hypertext, pull down menus, on-line help facilities, and a tutorial were built into MSES to help insure that users would find the system friendly to use.

A user acceptance questionnaire was provided to the target user and media specialist after they worked through the MSES. The user acceptance results are presented in Figure 3.

Overview of MSES

The MSES consists of three major modules: the Demonstration Module, the Editors and the Media Analysis Module. The Demonstration Module is written in PC-PILOT and PC-Paint brush was used to create all the graphics. The Editor is written in PC-Pilot; utilities programs in the advanced features library were also used. The Media Analysis Module was developed by using VP-Expert shell. During the consultation process, external Turbo Pascal programs were called in to handle the computation and data input/output task. The stages of MSES reasoning process are shown in Figure 4.

When consulting with the MSES, users are first asked to input instructional objectives; this is represented in the first block of Figure 4, Input Training Objectives. In the second and third blocks, users view a list of the media and the media selection attributes that are referenced in the MSES. If users are not familiar with any of the entries, they can access hypertext files to obtain detailed descriptions of specific media and media attributes.

In the next phase of the program, MSES requires users to assign weighting factors to each media selection attribute according to their relative importance to their instructional objective. This feature is built into the program because the only the MSES users can understand their audience and local training environment. Thus MSES makes media selection decisions based on both human experts' knowledge, and users' judgements.

To insure useable recommendations, the program requires users to identify those equipment and facilities that are available for instruction. Refer to Blocks 5 and 6 in Figure 4. The MSES produces media recommendations based on the complete set of media available to users and on the basis of the media pool that the user has immediately available. The first set of recommendations is provided to allow users information so that they can justify obtaining the most appropriate media for a learning objective. The second set is provided to give the user practical information when designing instructional packages.

The MSES is designed to allow users to identify media for multiple training objectives. This process is streamlined by having the program record the media that the user indicates are available for the first learning objective. Refer to Figure 4, Block 5. This results in the MSES reasoning process being much simpler for additional objectives. Users only need to input a new set of weight factors for each additional learning objective. The MSES reasoning process for additional objectives is represented in Figure 5.

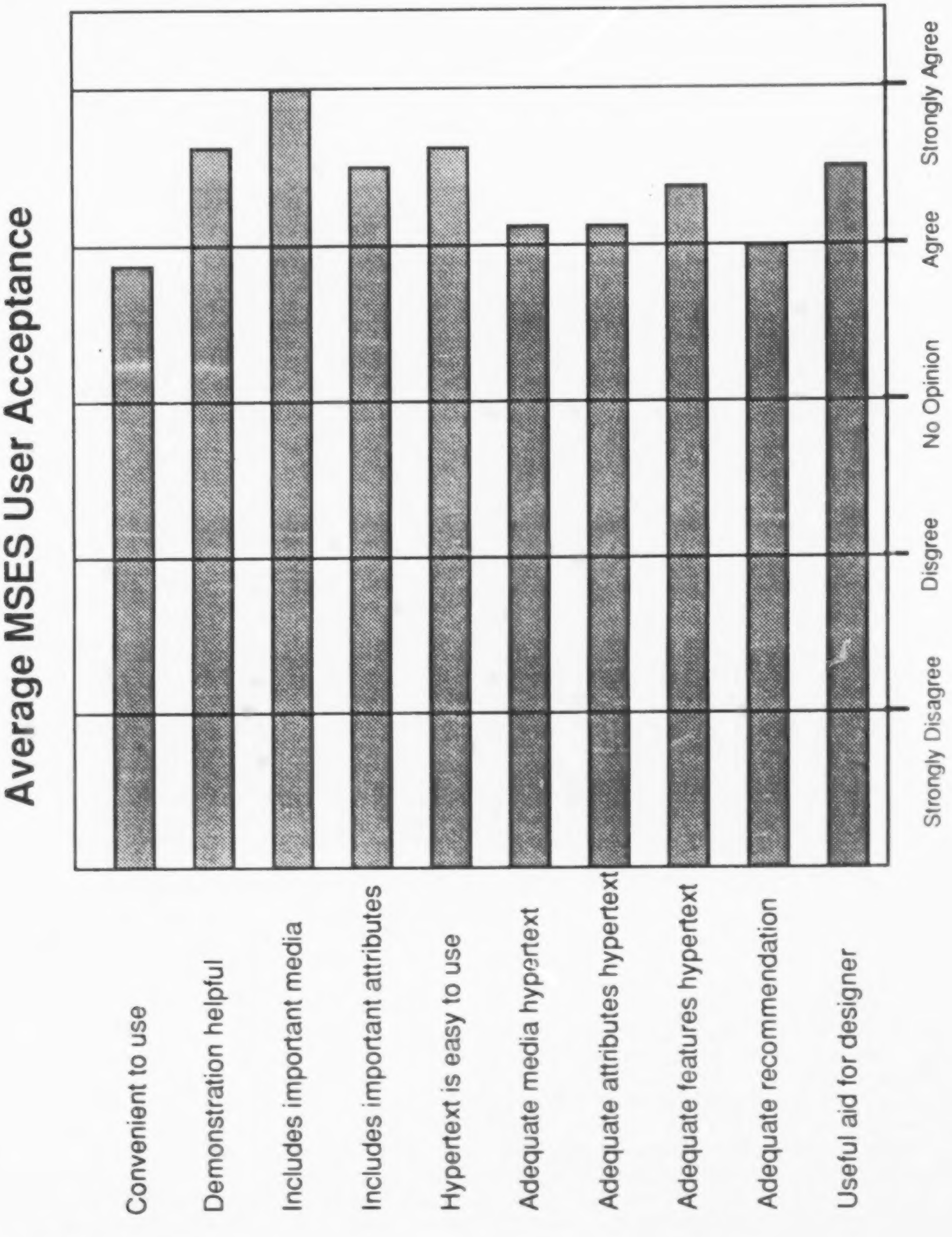

Figure 3. MSES user acceptance.

Conclusion

Because the evaluation of expert system is expensive and time consuming, most of the expert systems available today are not evaluated Formal validation, verification and user acceptance has been conducted on the MSES. The results demonstrate that the MSES is easy to use, the hypertext files are helpful, includes important media and media selection attributes, and provides high quality recommendations. Feedback from future users will be incorporated into new versions of the system.

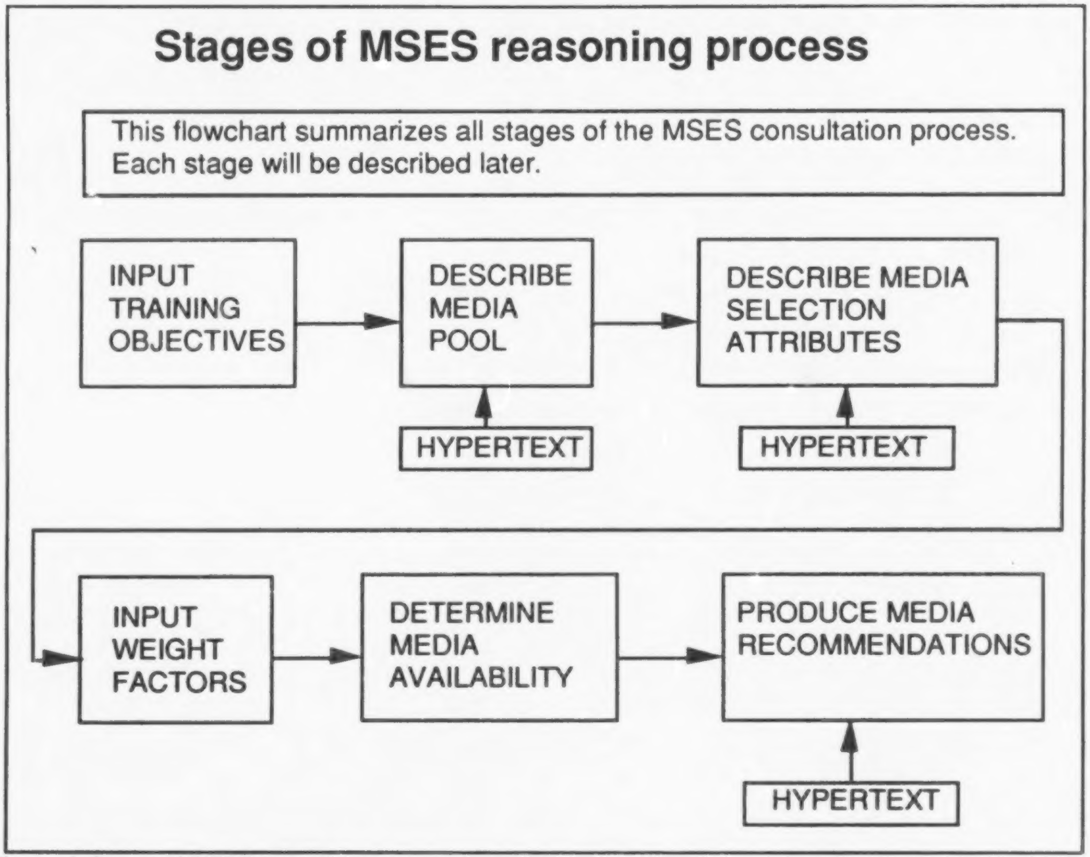
Stages of MSES reasoning process
This flowchart summarizes all stages of the MSES consultation process. Each stage will be described later.
INPUT TRAINING OBJECTIVES
DESCRIBE MEDIA POOL
DESCRIBE MEDIA SELECTION ATTRIBUTES
HYPERTEXT
HYPERTEXT
INPUT WEIGHT FACTORS
DETERMINE MEDIA AVAILABILITY
PRODUCE MEDIA RECOMMENDATIONS
HYPERTEXT

Figure 4. Stages of MSES reasoning process.

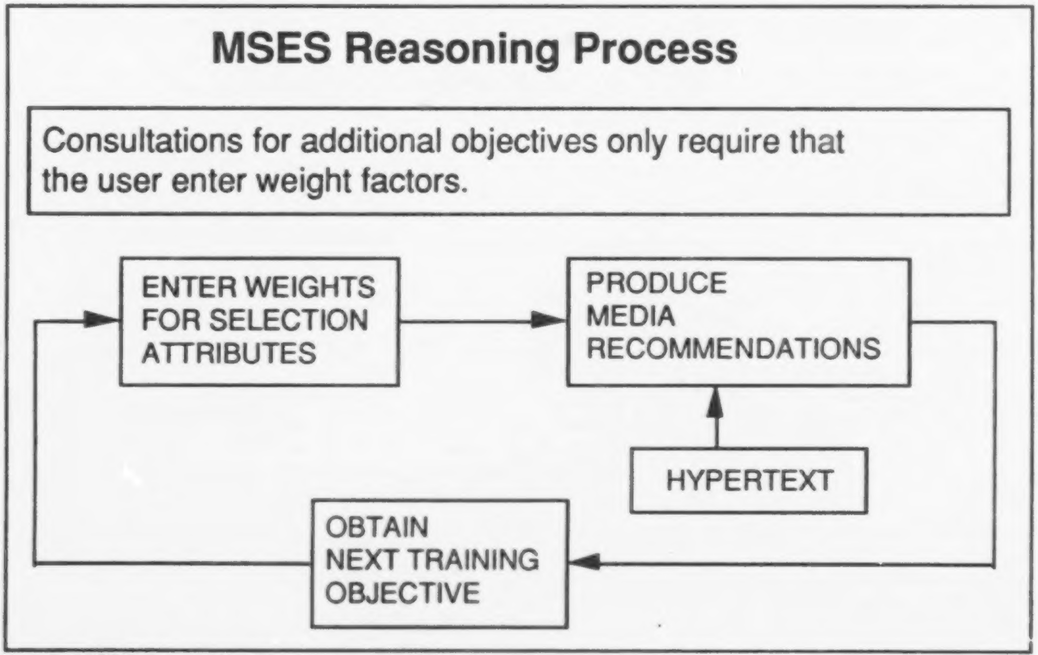
MSES Reasoning Process
Consultations for additional objectives only require that the user enter weight factors.
ENTER WEIGHTS FOR SELECTION ATTRIBUTES
PRODUCE MEDIA RECOMMENDATIONS
HYPERTEXT
OBTAIN NEXT TRAINING OBJECTIVE

Figure 5. MSES Reasoning Process

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THE INSTRUCTIONAL DEVELOPER, EXPERT SYSTEMS, AND THE FRONT END PROCESS

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Introduction

This paper is intended to provide the instructional technologist having some understanding of expert systems with further insight into two of the many steps involved in the design and production of such systems: KNOWLEDGE ACQUISITION and KNOWLEDGE STRUCTURING (also known as KNOWLEDGE REPRESENTATION). It is also intended to help instructional technologists to see how they might fit themselves into the knowledge engineering (expert systems building) paradigm and to help knowledge engineers to identify domains of instructional development research and practice from which they could benefit.

We will begin by examining a generalized model for the design and production of an expert system. We will then look in more detail at the first two steps in this model, knowledge acquisition and knowledge representation (structuring). The relationship between the instructional development process and the knowledge engineering process will be emphasized. Finally, characteristics of the ideal knowledge acquisition engineer will be compared to those of the ideal instructional developer. It is hoped that these points will show that the two processes are very similar, and that a cross-fertilization of both ideas, techniques and people between the two fields will prove both possible and profitable.

The Model

The expert systems design and production model of interest to us is shown in Figure 1 (adapted from Martin and Oxman, 1988). As this figure shows, the first task involved in designing an expert system is to select an appropriate problem to solve. This is possibly the hardest task to accomplish properly for the knowledge engineer. A great many of the jobs we perform every day as instructional technologists are currently unsuitable for expert system development. (Of course, as we develop better technology, it is exactly these kinds of fuzzy problems that will eventually provide us with the greatest benefits, once we have developed an adequate way to deal with them.)

For example, any task which is based upon hard-to-define knowledge, common sense, or intuition is currently unsuitable, given the existing state of the technology of knowledge representation and expert system design. So is any task in which it is unclear whether, when completed, the potential user would ever in fact use the expert system. Many other characteristics must be met by the ideal task if it is to be suitable (cf., Martin and Oxman, 1988, p.130).

Once a problem has been selected, the next step is to obtain the data-base or set of knowledge that is the property of an expert working with this problem. There are several aspects to this step, and these will be discussed later in the paper. It is sufficient here to note that this step is probably the most time consuming and expensive step in the design and production process. It involves locating a suitable expert (called subject-matter expert, or SME, in instructional development, and a domain expert in knowledge engineering), eliciting from the expert the required knowledge, understandings, judgmental procedures and hunches, writing this knowledge in a logical and explicit form, and verifying the correctness of this written structure with the expert (Texas Instruments Teleconference on Expert Systems, 1987).

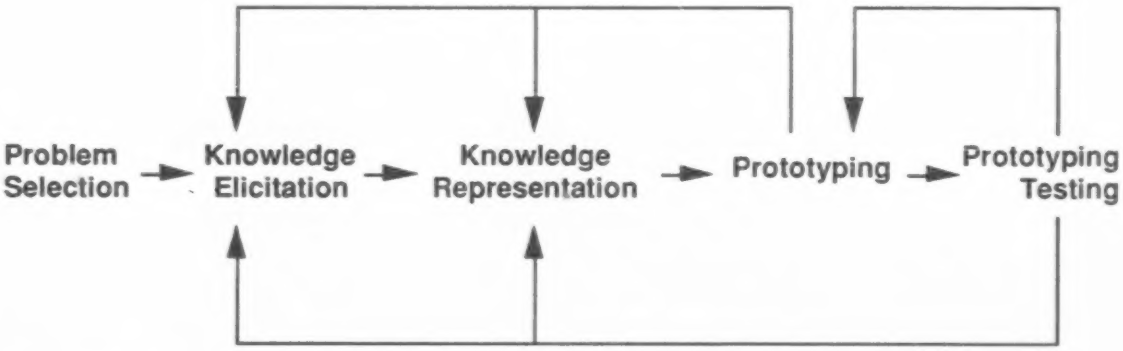

Figure 1 The Expert Systems Building Model

The third step of interest to us is that of knowledge structuring, or knowledge representation. This task involves converting the acquired and verified knowledge into a structure the computer can use and which is best designed to enable the user to employ the resulting computerized system. This step, also, is composed of several parts. The knowledge must be structured in such a way that the original relationships among facts, descriptions, procedures and probability spaces are maintained. It must also be structured in such a way that it can be used by the inference engine (that part of the expert system that makes decisions, inferences, and conducts other reasoning exercises). It must be structured in such a way that the factual aspects of the knowledge structure can be stored in a data base, and in such a way that efficient and convenient search-and-retrieval strategies can keep the inference engine supplied with whatever data it needs to function properly and rapidly; and it must be structured in such a way that a user interface can be constructed to the expert system enabling the user to easily ask answerable questions based upon the acquired expert knowledge. Many structuring schemes have been developed, and which one is best to use for any given problem is a factor of the knowledge domain, the type of questions to be asked by the user, the structure of the inference engine, and the expert language or shell to be used. The resemblance of this process to task analysis, media selection and other knowledge representation aspects to the instructional design process will be discussed later in this paper (Martin and Oxman, 1988; Waterman, 1986; Benchimol, Levine and Pomerol, 1987; and Taylor, 1988).

The rest of the design and production process for expert systems is much more closely related to the computer programming profession than to the instructional development profession, and so in Figure 1 all steps subsequent to knowledge representation have been lumped into one, prototyping, with one exception, prototype testing. Prototype testing is another step in the process that should sound familiar to the instructional developer. It is evaluation, including summative, formative and process, and both obtrusive and non-obtrusive, both normative and criterion-referenced, all thrown into a single pot and stirred well. Again, we will discuss this below.

One area in which the instructional developer and the designer of expert systems can help each other, but which is not represented in the model given here, is in the design of the user interface. The user interface is that part of the computer system that includes the displays shown to the user, determines what inputs and other responses the user is allowed to make, and what responses the computer system can return to the user. In the case of expert systems, as with good CBI systems, the user interface also includes (and is based upon) a model of the user. In the case of the expert system, this model may be an intelligent system in itself (Systems Group, The Open University, 1987); a special language interface, known as a natural or quasi-natural language, may be employed, and this is in itself a kind of artificial intelligence system (Martin and Oxman, 1988, p.226).

This, then, is the general model of how an expert system is designed and produced. It is an overview, and much of importance has been omitted. But it should be sufficient to show those areas in which instructional developers can play a part, based upon a similarity between what they normally do and what must be done to produce an expert system. Let us now examine some of these similarities in more detail, beginning with the problem selection step.

Problem Selection for Expert System Development

The selection of an appropriate problem for use in designing an expert system is extremely crucial to project success. However, this is not easily accomplished. Four issues are involved: identification of the task to be accomplished, identification of the people involved in producing the system, identification of the final objectives and users, and identification of both required and available resources (Benchimol, Levine and Pomerol, 1987, p. 162).

Usually a general type of problem is easily selected, in terms of either its research value or in terms of its practical value within the organization proposing the project. But this problem must be narrowed and defined, and it must be understood how the project based upon the problem might proceed. The problem to be solved must be examined in detail in order to produce a high-level design for the expert system that is going to solve the problem. The refining of the task and the definition of the expert system in terms of that task must often occur within a vacuum of knowledge about either the problem or the resulting system, much as is the case in the front-end definition of a job or task analysis which, eventually, will lead to some instruction or a simulator design. Often, for example within the military procurement system, the simulator and training system must be designed long before the weapon system it supports has even been prototyped. The selection of a problem and the conceptualization of its solution often occur within a similar atmosphere.

One area of critical importance is the selection of the expert. An expert must be available to provide the knowledge upon which the expert system is to be based, or no expert system can be produced. The first aspect of this problem is to determine the level of expertise needed. Not all (in fact, not most) expert systems are intended to function on the leading edge of a field, performing state-of-the-art work. Most are intended to aid or replace workers having a low to moderate level of expertise, or to help entry-level workers. Some are intended to perform routine aspects of a complicated multi-step procedure, or to relieve experts of routine aspects of their work. A state-of-the-art level of expertise is not needed for this sort of task. More expertise is needed on the part of the human expert supplying the developer with the knowledge base than is intended to be incorporated into the program, but a world-renown expert is not needed to provide the knowledge base for advising an entry-level clerk. Further, on those projects in which top-level expertise is needed, some of the demand for the expert's time can be relieved by providing a lower-level expert for use during the initial efforts. Thus, the determination of the type and level of expertise needed is very important. There seems to be no model or theory of how to do this at the present time. Some work is being done on defining the nature of expertise and of the expert (Hart, 1986). Most instructional development projects involve the identification of the subject-matter expertise needed, both in terms of quantity and of level of expertise represented, as a part of the original project plan. A theoretical foundation for doing this within the instructional development world has also not been developed, but most instructional developers do this intuitively fairly well. Further, a couple of approaches of a procedural nature have been developed.

One of these methods for defining the required level of expertise is to define mastery. This is done by analyzing the tasks to be performed in the area under consideration, and then preparing behavioral objectives for these tasks. Criteria defining an adequate performance for each of the objectives are then established. The sum total of these objectives, within the limits set by the performance criteria, defines the expertise needed. This expertise is defined directly in terms of the behaviors the expert must be capable of, and indirectly in terms of the knowledge the expert must have in order to perform these behaviors. How does one judge whether or not the set of objectives covers an adequate amount of expertise, and how does one know if the criteria are adequate to ensure expert performance at an acceptable level? By applying the 80/20 rule. This rule states, as a rule of thumb, that the knowledge base established with 20% of the content required to establish the complete knowledge base will be adequate to solve 80% of the problems the expert system will encounter. This rule of thumb is not always accurate, but it generally works. To judge the adequacy of coverage of the objectives and their criteria, examine the problems in an actual real-world environment, and classify them into those the objectives and criteria adequately handle and those that they do not handle satisfactorily. When 80% of these problems are adequately handled by your set of objectives, you have established an adequate definition of the required expertise, both in terms of breadth and of depth. The methods currently being used by instructional developers can undoubtedly be improved upon through the development of a better theoretical understanding of the nature of expertise, and of better procedures based upon this improved understanding. This area should prove to be a fruitful area of theory building for instructional developers.

The users of the system must be identified at this stage, and again, instructional developers have a long history of dealing with this problem, both successfully and unsuccessfully, as also have evaluation specialists. Who are the real clients for the products resulting from a project, and are they the same people who are the clients for the development process? Are they the same people who are paying for the project? Are they represented in the design process? Can the project succeed if they are ignored? Here, again, is an area in which both instructional development and knowledge engineering can benefit through the explication of the processes normally used in the instructional development and evaluation fields.

Instructional developers are familiar with the process of resource identification as a part of the initial planning phase of a project, and the same is true of the knowledge engineering project. Before the problem is finally settled upon, it must be clearly understood what resources are going to be needed, and from where they are to come. Standard resource allocation and project scheduling techniques are applicable here, but the peculiarities of the expert system development process must be kept in mind during their application (Benchimol, Levine and Pomerol, p. 164). More published case studies of this phase of expert system development projects are needed, especially in detail great enough to show how standard processes can be applied, and how they must be modified in order to serve the expert systems project.

Knowledge Elicitation: Human Relations Aspects

Knowledge elicitation and knowledge structuring or representation are often considered to be one task by writers on expert systems from the computer world. One reason for this is that they are often performed by the same people, and another is that they are usually performed simultaneously. A third reason, we suspect, is that the typical knowledge engineer knows far more about knowledge representation than about knowledge elicitation, at least in a formal or structured sense.

One characteristic shared in common between the instructional developer and the knowledge engineer is the need to conserve the expert's time during knowledge elicitation. The least amount of time the knowledge engineer requires of the expert, the cheaper the project cost will be and the faster the project will be completed (Martin and Oxman, 1988, p.434). However, very little knowledge exists concerning how to minimize the time required of the expert. The knowledge engineer should become generally familiar with the field before approaching the expert, through the reading of text books and other materials relating to the project. And he must be a good listener, quick thinker, and a rapid learner. These are also requirements for the good instructional developer. However, these are minimal requirements for optimization of the expert's time. Much more work needs to be performed concerning making optimal usage of the expert's time.

The knowledge elicitor must also maintain the expert's interest in the project, make sure he understands the role he is to play, make sure he understands the level of knowledge desired, and make sure his good will towards the project and towards the knowledge elicitor is maintained. If a failure in any of these things occurs, an accurate diagnosis of the problem is absolutely necessary if the damage is to be repaired. Again, within the realm of knowledge engineering these aspects of knowledge elicitation have not been formalized in any theory, and are usually dismissed after a short discussion summarizing their importance to project success and then stating that they call for the knowledge engineer to exhibit good communications and personal relations skills. While this is certainly true, it is not enough to be of any specific help in conducting a specific project.

Several lines of research conducted in instructional development can be of use in dealing with these problems, and should be extended (both within the instructional development field and as applied to the expert system development process). Research on client-consultant interactions, initial meetings, appropriate model, and role changes at different points in the consulting process, have been conducted, and some efforts have been devoted to teaching students to apply the findings of this research (Rutt, 1984; Price, 1984; Coscarelli and Stonewater, 1984). Further, preliminary work by Gentry and Trimbly on the formal analysis of communication interfaces for instructional development projects (Gentry and Trimbly, 1984) certainly has applicability here. A recent review of the interpersonal skills required by instructional developers has been prepared by Curtis (1990). Work in describing and prescribing the consultant relationship has also been conducted in other fields, such as medicine and personnel psychology (i.e., Johnson, 1978; Schein,1978; and Tilles, 1961). Again, these studies need to be followed up, and ways in which the knowledge elicitation process is similar to and different from the models researched in the cited studies needs to be explicated. The methodologies for conducting and applying this research are already to be found in the instructional development literature.

Knowledge Elicitation: Methodologies

The most commonly-discussed aspect of knowledge elicitation within the knowledge engineering literature is that dealing with formal approaches to the elicitation of knowledge from the expert. Robert Pearson (Pearson, 1988) provides a good summary of the most commonly-discussed methods. These are the structured interview, the use of probability estimation, machine induction and the Repertory Grid. Other methods discussed in the literature include the use of historical records, observation, both obtrusive and non-obtrusive, thought experiments, and case studies (Martin and Oxman, 1988, p.175).

The general methods described in these sources are for the most part those methods the instructional designer is already familiar with and to some extent an expert in. Some exceptions might be the Repertory Grid, machine induction, and probability estimation. Pearson also discusses some aspects of the structured interview that may not be familiar within instructional development.

The Repertory Grid is a "tool used by psychologists to represent a person's view of a problem in terms of elements and constructs" (Hart, 1986, p. 174). The grid is a two-dimensional table (characteristics X cases). The characteristics are bipolar, such as strong and weak. The cases are rated on each characteristic on a scale of 1 to 5. Instructional developers have used such matrices in other contexts, such as with the semantic differential, attitude measurement, and in attribute learning theory research. Once such a matrix has been developed by the expert, it can be analyzed for patterns, either through inspection or through more sophisticated methods, such as factor analysis, cluster analysis, or profile matching (Pearson, 1988; Hart, 1986). Further, since the world view of each expert is likely to be different from that of any other expert, it is often profitable to compare the grids of different experts.

Machine induction is a process in which the computer generates generalizations when given specific examples (called training sets) as inputs. Special software, called inductive algorithms, has been developed to carry out this process. As Pearson points out (Pearson, 1988), the results are only as good as the examples chosen for inclusion in the training set. Further, this method can only be used with knowledge to the extent that it can be reduced to numerical representations.

The development of a probablistic knowledge representation is based upon the assumption that much of an expert's knowledge is of a non-exact nature. Thus he is asked the degree of certainty he attaches to various of his decisions and recommendations. These are represented within the expert system as weights attached to other outputs, and attempt to mimic the expert's judgements in these matters (Pearson, 1988).

To use these methods of knowledge elicitation, the knowledge engineer clearly needs an in-depth understanding not only of the particular technique being used, but also of statistics and mathematics in general. Typically instructional developers and evaluation experts do not have such an extensive background in quantitative science. However, through appropriate training, they could be provided with such a background. Not only would this equip them for performing knowledge elicitation tasks for the development of expert systems, but would allow them to use the knowledge engineering methods within more traditional instructional development projects.

On the other hand, the instructional design and development literature is replete with descriptions of practical approaches to job and task analysis, which have shown themselves to be effective and relatively efficient (see Carlisle 1986). Whereas the bulk of these techniques were developed to analyze procedural tasks, there are some, such as Critical Incident Analysis, Problem Analysis, or Case Analysis, which have a track record of success in the domain of complex heuristic tasks such as management decision making. The study of these methodologies may enhance the efficiency of knowledge engineers in performing the knowledge elicitation stage of expert systems development.

Knowledge Elicitation: Methodologies

In general, the problem of knowledge elicitation faced by the knowledge engineer is more difficult than that faced in the typical instructional development project (although, of course, there are exceptions to this) (Dills, 1988). This stems from the fact that the level and type of knowledge that the expert system must model is usually of a much more complex, more fundamental, and a less well defined nature than is the knowledge typically represented by a CBI system or a textbook. A greater similarity exists between the two types of knowledge when the instructional developer is attempting to mold the student's attitudes, represent non-verbal behavior for the student to model, or to teach in interactive process through the shaping of behavior during interactive practice sessions. It is in developing a knowledge base for these instructional activities that the instructional developer experiences the greatest difficulty, and the standard methods for task analysis and content analysis are most likely to fail. And these tasks are similar to ones the knowledge engineer must face, especially in projects in which the expert system is to exhibit a high level of expertise.

The expert system must not only incorporate factual knowledge, but also must represent procedures, concepts, principles, and standards. But this is only the beginning. The expert system must reason in such a way as to mimic the expert. It must make judgments which are only probably true, it must make them as the expert would, and its judgements must have (at least) the same probability of being correct as the judgements made by the expert himself.

Further, the expert system usually contains an explanation facility. The Explanation Facility tells the user, usually upon request, how a particular decision, recommendation or conclusion was reached by the expert system. This includes displaying the reasoning pattern used, the data analyzed, and the rules utilized. Thus, the expert system must have built into it not only sufficient knowledge to duplicate the expert's outputs (conclusions, recommendations) but must also be able to describe the expert's thought processes and reasoning patterns (Matrin and Oxman, 1988, p.28).

There are projects in which only one expert is used. It may be that the level of expertise required is such that any expert in the field would do, or that little differences among experts are unimportant at the level of the project. It may be, also, that only one expert is available to the project, or that only one expert exists at the level of expertise required. Normally, however, more than one, and in some cases several, experts are utilized. Sometimes the experts are equally utilized, as a team. More often, they are used to provide expertise about different aspects of the problem to be solved. When they are utilized to different degrees, sometimes one is the central, or main, expert, and the others are used to validate the knowledge base of the main expert, or to supplement it. Other times, the main expert is used only after the other experts have laid an appropriate groundwork, thus conserving the main expert's time. In some cases, unfortunately, the main expert is lost sometime after the project has begun, and other experts must be utilized to replace him.

In all of the multiple-expert situations listed above, the knowledge elicitation problem is complicated by the special problems involved in reconciling and validating the experts with one another. The communications and human relations problems become much more complicated because of the increased number of people involved and the greater chance for emotional problems to develop. One of the best methods currently used in such situations, by the way, is the Repertory Grid, especially when coupled with structured interview techniques.

Another aspect of importance in the understanding of expertise is to understand the expert as a person - his world view, his philosophical bent, his pre-conditioned reactions to specific types of situations. The knowledge base in the philosophy of science, the psychology of the human world-view, and the nature of the scientific method that many instructional developers and evaluation experts possess, is typically not found among professional knowledge engineers. The instructional developer can make use of this knowledge in trying to establish the reasoning patterns and paradigmatic aspects of the expert's understanding. This should enable the instructional developer to more quickly model the more fundamental aspects of the expert than would someone lacking this background (see, for example, Davies, 1984; Stahl, 1984). A methodology for the generation of methodologies was developed by Hutchinson and his associates (Hutchinson, 1984). This could be adapted to the purpose of formalizing the use of the foundational knowledge from philosophy and psychology for the development of new methods for eliciting the deep structure of the expert's world-view concerning the problem at hand. Such developments should prove fruitful not only to knowledge engineering and instructional development, but also to cognitive psychology and the philosophy of science.

Yet another area of development is the design of software for use in knowledge acquisition. One type of software, just beginning to be developed, is the knowledge acquisition facility (Olson 1990). This is a part of the software that carries on a dialogue with the expert, eliciting knowledge and procedures from him, and directly inserting them into the data base. Such a system may be specially designed for the system being constructed, or may operate through the user interface. The same system may be utilized later to update or expand the expert system as new knowledge is acquired and old knowledge becomes outdated (Martin and Oxman, 1988).

A second type of software of use in the knowledge elicitation process is a software package that tracks pieces of knowledge throughout a computer system and other developmental processes as well, and identifies inconsistencies within the data base, as well as redundancies. One such system, called TRACE, is currently under development (Olson 1990).

New methods for eliciting knowledge are badly needed within knowledge engineering. Current methods are time consuming, costly, and are not guaranteed to properly elicit the needed knowledge without the intuitive intervention of an experienced knowledge elicitor. As in instructional development (Dills and Bass, 1984), much of the knowledge elicitation function of knowledge engineering is currently an art form, not a technology, and so cannot be automated. Perhaps this will always be the case, but at least it should be possible to develop better techniques to use when performing the art. Instructional developers are in a good position to develop some of these, and would certainly benefit in turn from any such new techniques that might be developed.

Knowledge Representation

Knowledge in an expert system is structured, or arranged, in two parts, which are built and stored separately, and which are designed to interact with each other. One part is called the inference engine, and contains the knowledge concerned with how to reason. The other part is called the knowledge base, and contains the facts, rules and other types of knowledge used by the inference engine in reasoning.

The knowledge engineer must decide what structure to use in arranging and organizing the knowledge base so that it can be accessed and utilized by the computer, and ultimately by the user, in the most efficient and effective manner. To do so, two questions must be answered. The first is how the inference engine is to function. The second is how the knowledge is organized within the knowledge domain. Both of these questions must be answered in terms of the logic of the field in question, and also in terms of the logical structures available within the computer.

Several structures for representing knowledge within the knowledge base have been developed, and are usually described in terms of how various aspects of the expert's knowledge relate to each other. Special languages have been developed to simplify the implementation of these structures, and these are likely to be used in any significantly large project. They reduce time and cost for constructing the expert system, but they also add their own restrictions and limitations to the resulting system. Therefore, one decision that must be made is which language is to be used to structure the knowledge. This decision must be made simultaneously with the decision concerning which logical structure to use in representing the knowledge (cf., Waterman, 1985, Chapters 3, 7 and 8; Martin and Oxman, 1988).

The instructional developer is not likely to be familiar with the ways in which knowledge can be structured within a knowledge base. However, he does perform tasks which are functionally similar. He structures the flow of information within lesson designs when producing CBI. If he micro-designs the CBI lesson, he structures the knowledge even more carefully. In doing this, he undoubtedly tries to discover an internal, natural structure to the subject matter being taught, and uses this structure in designing his lessons. He also attempts to structure the information according to design heuristics, and according to what is known concerning the psychology of learning. In designing a CBI or textbook page, he attempts to make use of the research on text design, and is therefore applying another logical structure to the information. In doing these things, the instructional developer is restricted by the CBI authoring language, the subject matter structure, and the needs and abilities of the user, much as is the knowledge engineer.

Four knowledge representation schemes dominate the knowledge engineering field, and the instructional developer should be familiar with these if he is to work with expert systems. These are rules, frames, semantic networks and first-order logic. Others are being developed, and eventually may supplant the four. One should be aware of these, but currently almost all work is performed using one or more of these four methods (Martin and Oxman, 1988).

Rules are the most commonly-used form. Knowledge is represented as a series of logical IF-THEN statements, and the inference engine calls these rules in a sequence determined by the subject matter, determines if the IF statement has been fulfilled, and if so, carries out the THEN statement. The THEN statement may be to take an action outside the computer, such as print out a decision, or to change an internal variable, such as establish the numerical value of a variable in an equation.

Frames and semantic networks are similar, and both depend upon groupings. Semantic networks consist of a series of nodes connected by lines. When drawn, a diagram representing a semantic network looks much like a flow chart for an instructional development project, or a PERT chart. The nodes represent concepts, and the connecting lines represent relationships. There is a hierarchical relationship among the concepts, such that concepts lower in the diagram inherit the characteristics of concepts higher in the structure. Thus a kind of umbrella arrangement exists. If "ship" is a high-level concept, and it is a characteristic defined into the system that "ships" have "hulls", then, if "aircraft carrier" is a lower-level concept, and is connected to the concept "ship" by the "is-one" relationship, the inference engine will automatically infer that "aircraft carriers" have "hulls" (Waterman, 1986).

Frames are similar to semantic networks. If the nodes are considered frames, then the frames indicate relations to other frames. Each frame is a container, and the lines in the diagram connect the frames, and indicate frame-to-frame relationships. The frame itself can be considered a concept. The designer then puts facts, procedures, concept names, design information (as the name of the expert who uses the concept) into the frame. This information is stored in slots. Each frame has a certain number of slots, or pigeonholes, and each piece of information fills one or more slots.

Thus each frame is a cluster of related facts, and the cluster itself relates the facts to other clusters. The frames may or may not have an umbrella relationship as described above for semantic nets (Benchimol, Levine and Pomerol, 1987).

First-order logic as a knowledge-representation scheme involves representing the internal structure of the knowledge domain using prepositional logic. The facts and other objects of the domain are represented as elements within propositions, and propositions are related through the use of propositional logic. Such a framework has the advantage that it is a mirror image of the knowledge domain and/or of the expert's deep mental structure. It has the disadvantage that it must be tailor-made for each application, at least if it is to be maximally efficient and yet preserve its nature as a mirror image of the expert's mental structure; it does not lend itself readily to incorporation into a commercially-provided shell (although, when an exact mirror image is not needed, a shell can be used to provide an approximation to this structure using this representational scheme).

Declarative knowledge can be represented by various types of logical structures. Commonly used are propositional calculus, predicate calculus, first-order predicate calculus, and Horn clause logic. Statements such as "Lassie is a dog" and "If Lassie is a dog, then Lassie is a mammal" would result in the inference engine deciding that "Lassie is a mammal" in these systems. More concerning these types of representations can be learned from Martin and Oxman, chapter 10, or Benchimol, Levine and Pomerol, chapters 3,4 and 5.

Again, most instructional developers do not have a solid background in symbolic logic, and so will have trouble with these schemes. However, this situation could easily be remedied by a short course in the instructional development department or a summer institute if enough developers wanted to work with expert systems. And these schemes are easily learned, so developers can learn them on their own. If one is to serve as a front-end expert on an expert-system project, one must become familiar with these schemes in some manner.

One of the areas in which developers can aid the expert system field is to develop ways in which the internal structure of a field can be easily and quickly determined, so that this information can be used in determining how the knowledge is to be represented. Again, the structure of the field can probably always be deduced from information concerning the paradigmatic and other world-view features of the expert's knowledge structure. As argued earlier, a formalized method for determining the paradigm of the expert and of translating this into a knowledge structure could be developed, and would be very useful. Further, most knowledge engineers have no background in this area, and many evaluators and instructional developers do.

The structure of the inference engine must also be determined, and several structures (in this case, procedures for reaching a decision) are in common use. Often a ready-made inference engine is purchased, rather than custom-made, but again, its workings must be understood if an appropriate purchase is to be made. Some of the most common inference schemes are (Martin and Oxman, 1988, p.64):

backward chaining
forward chaining
breadth-first search
depth-first search
heuristic search
problem reduction
pattern matching
unification
event-driven control
hierarchical control

These methods of inference will not be described here, since they are fully discussed in the references. But the instructional developer must be familiar with each of them, so that the proper inference technique can be matched to the problem at hand, and the knowledge base can be represented so as to properly fit the inference engine. The knowledge elicitor must be familiar with the ways of building an inference engine and a knowledge base, since the way the knowledge is structured and used must be decided as the knowledge is being acquired. Typically an expert system is being prototyped as the knowledge structure is being developed, and early decisions are both necessary and critical to future expansions. Thus, the instructional developer, if he is to utilize his knowledge of front-end analysis in knowledge acquisition for expert systems development, must become knowledgeable concerning how this knowledge is to be structured and utilized by the computer system.

Thus the instructional developer is required to develop a knowledge of inference engines and knowledge representation schemes, and this requires that he develop a knowledge of logic, and of various inference schemes. It does not require him to become a computer programmer or a systems engineer. It does require that he become familiar with the languages typically used in expert system work, but on a conceptual level. In most projects, the programming will be performed by a specialist. But the developer must communicate with this specialist, and must know the restrictions and advantages placed upon him by the language being used.

Testing

Not only must the resulting computer programs be tested, but the resulting knowledge structure and inference patterns must also be tested. Further, the usefulness of the resulting product to users, and the need for updated knowledge, must be evaluated. These things must not only happen when the system has been prototyped, but at each step in its evolution, and periodically after it has been completed and turned over to the customer. It is clear that instructional developers possess expertise of great value here, especially in designing and conducting user interviews, evaluating aging knowledge bases, and verifying system-made decisions against the real world.

User Interfaces

Instructional developers possess knowledge and experience in two fields that are related to the design of the user interface of expert systems. The first concerns screen design and human factors work. The design of the interface for the user is similar to the design of an interface for a CBI system, and furthermore, involves a great deal of screen and text design considerations. Further, the functional design of the interface will determine what the user can ask the system, the type and manner in which he gives the system data, and the type of reply he can receive. Instructional developers already have standard ways of discovering the appropriate forms for such interactions in terms of the user's intentions.

A second area in which instructional developers can make a contribution to the interface design is through their knowledge of cognitive styles. It is known that not all experts think in the same manner, and that, further, experts and novices in a field think differently. The expert system must reason as the expert does, at least in high-level exert systems. But if the user were an expert himself, and reasoned as the expert, he probably would not be using the system at all. This is not always true, of course, but often it is. Therefore, when the novice or the other user receives an answer to a question, and asks the Explanation Facility to explain how the answer was reached, it would be useful if this answer could be given both in terms of how the real expert would arrive at this answer (supposedly, this is also the way the computer arrived at the answer), and also in terms of how this answer could be arrived at following the reasoning style of the user. In other words, if the expert is a "reasoner by comparisons", and arrived at the answer by comparing various factors, this solution would be explained. The computer could translate this into the user's style, which might be "reasoning by contrasts", and present this chain of inference to the user also, once it learned what his own style was. Currently, no such system exists, but by modeling the student or other user, such a system could be developed and attached to almost any independently-developed expert system. Such a system would be particularly useful in training people to reason according to different styles, or in using expert systems as instructional delivery devices. Instructional developers are in prime positions to design such a student model/explanation provider.

Summary

It is argued that instructional developers are in an excellent position to make contributions to the field of expert systems development, particularly in the areas of knowledge acquisition, knowledge structuring, testing, and designing user interfaces. To do this, they must become familiar with the tools, systems and approaches used in the field by knowledge engineers if they are to make this contribution.

It is further argued that knowledge engineers and other people from the computer field who are involved in knowledge acquisition and structuring tasks can benefit from studying the techniques and approaches used in task analysis, needs analysis and similar enterprises. They can also benefit by becoming more sensitive to the nuances of meaning and mental structures of the expert being modeled, and one way to do this is through a study of instructional development, especially as this field incorporates knowledge from such areas as the philosophy of science and world-view psychology.

Once they have learned the fundamentals of the field, they can apply their specialized knowledge and experience both as practitioners and as researchers. In doing so, they will open up a new technology to educational use, as well as provide the knowledge engineer with new tools that he will find quite useful.

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CREATING HIGHLY INTERACTIVE LESSON MATERIAL OR LEARNING BY DOING

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Abstract

We present an extension to authoring systems for tutorial CAI. It enables authors to create lessons which are highly interactive: students can manipulate scenes, click on buttons, change sliders, etc. The extension improves understanding by shifting focus from passive reception of material to active interaction and learning-by-doing. The purposed system requires no programming at all, but relies on a graphical user interface for authors of tutorial material.

Motivation

In recent years there has been increasing interest in computer-assisted instruction. With the advent of cheap, but powerful workstations one of the major drawbacks of former CAI attempts, namely high costs, has disappeared.

We nevertheless believe that CAI has to change drastically to be applied universally. Current tutorial material lacks an important aspect: user interaction. Our experience as teachers has shown that many students faithfully believe that they understand what they just read or heard. But when it comes to applying this knowledge it soon turns out that there is a gap between understanding something and actually applying it. Only when you actually have to do something you really start to understand it (see, for example, Ehrmann, 1987).

There have been of course many attempts to overcome the passive role of students in typical tutorial lessons. Besides question-answer dialogs, which we won't cover here, since they are well established [see, for example HyperTRAIN (HyperTrain, 1989), cT (Sherwood, 1988a; Sherwood, 1988b) or TenCORE (TenCORE, 1985; Klass, 1984)], much effort has gone into simulations. There students can work in microworlds, manipulating parameters of a model, changing ingredients in a chemical experiment, etc. Simulations have their justification, but they still form their own niche of the broad spectrum of CAI: they are more interactive than plain tutorial material, but it is still the program behind the system, which actually does the necessary calculations or applies a certain strategy.

However, even simulations come short of highly interactive teaching. At the present time, a number of systems enable the student to have a more active role, especially in intelligent tutoring systems. Here, a student can sometimes take over the initiative and ask questions or request explanations. It seems that the effort to create such systems is far beyond what even a small team can accomplish. What we propose here is a system somewhere between simulations and intelligent tutoring: the student should have more means of interacting with the system, and should have a more active role which gives him better insight.

Let us look at some examples first, before we explain what the system looks like from the author's point of view. The first example is from computer science. Let us assume that the student is working through a lesson on heapsort (if you do not know how heapsort works, do not let it worry you here). Like all sorting algorithms heapsort has to exchange some numbers to get them into the right order. Each sorting algorithm has its own way of determining what numbers to exchange next. It is essential to understand how heapsort rearranges the numbers to be able to write a program that utilizes heapsort, or to analyze the amount of work necessary to sort n numbers.

Heapsort uses a binary tree for sorting of numbers. To test whether students understand how heapsort determines two numbers that have to be exchanged the students could be asked to do it on their own: they move the cursor to the position they think is right, drag the number away a little bit, take the other number and move it to the original position of the first number. Finally, drag the first number to the empty place where the second number was displayed before. Assuming that the students exchanged the correct numbers, they can now continue working. If the students chose the wrong numbers, the system would give them some feedback, redraw the original scene and ask them for another try.

The second example is taken from a course for mechanic apprentices. Let us assume that the students see a picture of an engine on the screen, and they are asked to take it apart. There is a certain order to do this. Instead of showing the students a multiple choice question (or similar restricted textual interaction) the students can take the engine apart by simply clicking on parts that have to be removed. The system keeps track of what has already been done to ensure that, say, a cover cannot be removed before all bolts have been removed.

Both examples show what we have in mind: students should have a more active role and actually do things instead of just describing them. We believe that a simple set of "interactors" will make it possible to create interactive pieces such as the two situations described above without any programming. How this could be done is described in the next chapter.

A Hierarchy of Interactors

An *interactor* is an object on the screen that reacts to input from the user in a certain way. We propose an object-oriented hierarchy of interactors which is shown in Figure 1. The hierarchy is similar to recent products in the arena of user interface management systems like InterViews (InterViews, 1987; Linton, 1989) or CommonView (Glockenspiel, 1989).

The hierarchy has some properties found in object-oriented systems: new objects can be derived from existing objects; objects inherit behavior and data from their ancestors and re-use code from them. This technique simplifies the creation of new interactors which on the one hand can have more powerful features than their ancestors and on the other hand can be restricted in their behavior. Deriving new objects from existing ones can be done without programming but with the help of modern graphical user interface techniques. A set of useful functions (including mathematical ones) must be made available for the author. Nevertheless it is important to give experts a chance to include programmed sequences (e.g. written in C or PASCAL) which increase the high flexibility of object oriented hierarchy of interactors.

An example of the advantages we get by deriving new objects from existing ones is a *DragButton* which is an area on the screen which can be clicked on and - as far as it is connected to graphics - can be moved together with its graphical representation to another place on the screen. We can make this type of interactor much more powerful if we derive a new interactor from it called *DistDragButton* which has the same features as the DragButton, i.e. clicking on the DragButton, moving it around and placing it to a special location, plus a new feature which calculates the distance between the actual position of the DragButton (i.e. the position of the mouse cursor) and a given path which - for simplifying the calculation - must be a polyline connecting the starting position and the destination position of the DragButton. This type of interactor can be used to watch the learner who has to follow a given path. If the calculated distance exceeds a given value the interactor will react in a way that can be specified by the author (e.g. with a beep) .

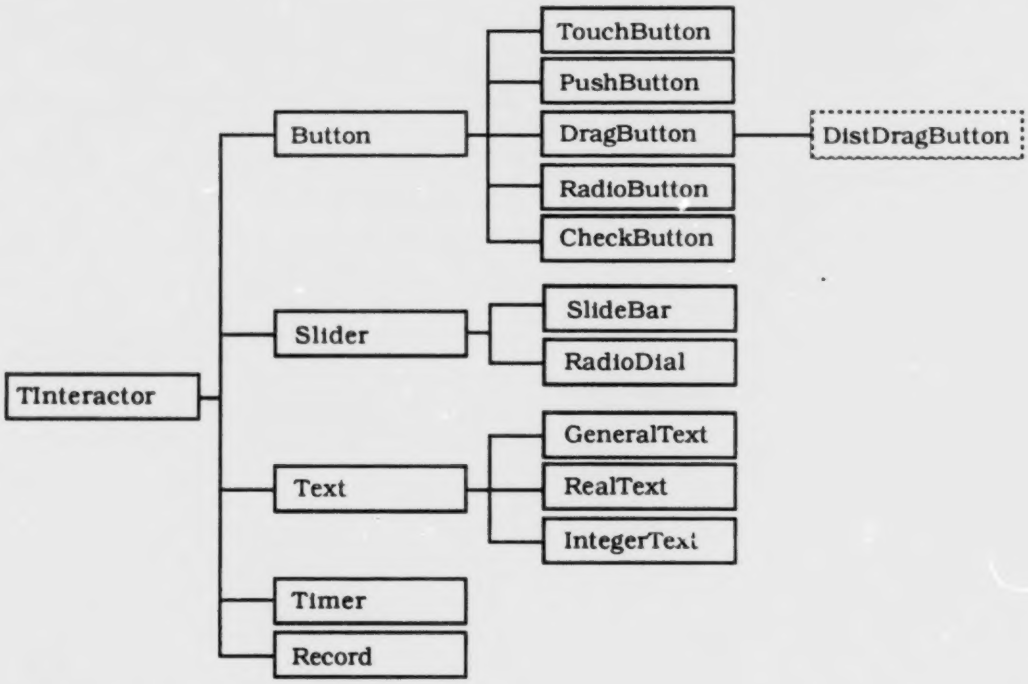

Figure 1.

A *standard library* contains the most important and most frequently used interactors. The more we concentrate different types of interactors in the standard library the more powerful the system will be. Figure 1 presents a collection of different interactors which we think should be a part of the standard library.

The basic idea of how an interactor reacts to user input is the capability to receive and send *messages*. Messages are in general a main characteristic of object-oriented programming languages. They are responsible for the communication between objects. HyperCard (HyperCard, 1988) is a good example of a system that extensively uses messages in connection with its own object-oriented hierarchy.

Each interactor is in one of two states: *awake* or *asleep*. Both *awake* and *asleep* are messages which can be sent and received by any interactor. When an interactor sleeps, it does not react to any messages (and hence, neither to user input) except the one message that sets it awake. Only after the interactor has been awaked, it will react according to its type. How it is awaked (and put to sleep again) is explained below.

In addition to the messages awake and asleep each interactor has its own typical messages it can serve. A *PushButton* for example can receive the message *click* which means that the mouse button was pressed with the cursor positioned inside the button area. The PushButton then automatically starts a set of actions which is associated with the specific message *click*. This action sequence varies with the individual and must be linked to the message by the author (as shown in Figure 2). Some messages are common to several interactors, since the capability to receive messages can be transmitted to the descendants of the interactor. The basic interactor *TInteractor*, for instance, which is at the root of the interactor hierarchy can serve four messages, namely the two already known messages *awake* and *asleep*, and *new* and *close*. All four must be available for all of the other interactors as well. The message *new* is sent when an interactor appears for the first time in a lesson, whereas *close* is used when the interactor disappears (afterwards it cannot be used anymore). Any action sequence can be linked to these messages. For example, *new* can be used to draw graphics onto the screen which belongs to the interactor and *close* can be used to erase all "rubbish" before an interactor itself is deleted.

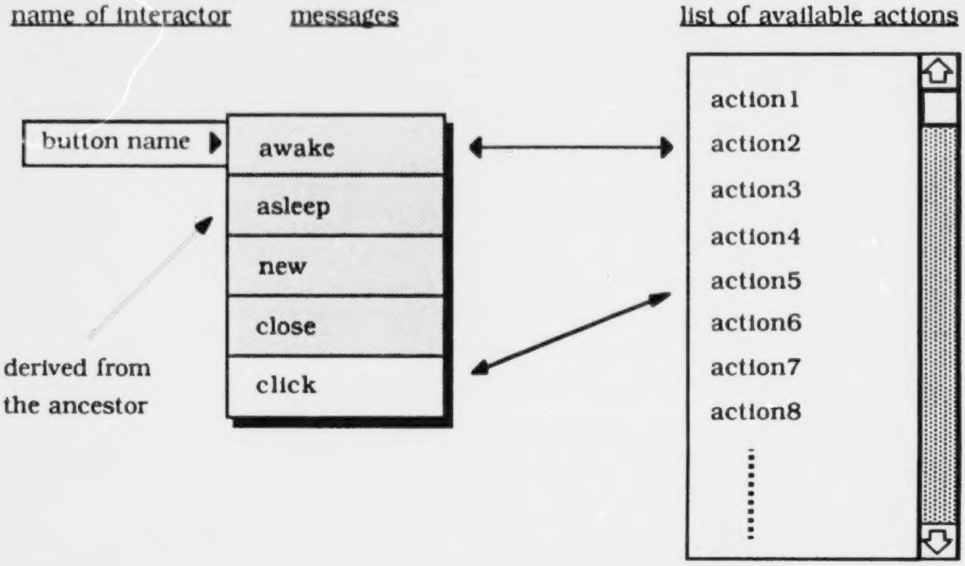

Figure 2.

In the following we want to give a short description of all the interactors listed in Figure 1, their characteristics and application:

TInteractor: is the basic interactor. It is an ancestor of all other interactors and has fundamental features which are common to all other interactors (serves the messages *new* and *close*, *awake* and *asleep*).

Button: A Button is an area on the screen (rectangular area by default) that can react to mouse input by starting an associated set of actions. It depends on the Button type which sort of input can be served.

TouchButton: A TouchButton is an area on the screen that reacts to cursor movement. Three different types can be distinguished:

touch_in starts a set of actions when the mouse cursor is moved from the outside to the inside of the TouchButton.

touch_out starts a set of actions when the mouse cursor is moved from the inside to the outside of the TouchButton.

still_in repeatedly starts a set of actions as long as the mouse cursor stays inside the TouchButton.

PushButton: A PushButton is a Button that can be clicked on. This is the standard type of interactor and will be the most frequently used interactor as well.

DragButton: A DragButton has like all buttons an area on the screen associated with it. By clicking into this area and keeping the mouse button pressed, the DragButton can be moved around the screen. Some graphic elements can be associated with a DragButton, and they will move correspondingly. There are two sets of actions associated with a DragButton: the first is executed if a DragButton is moved to the correct destination, the second one is executed otherwise. The default for moving a DragButton to a wrong location is no reaction at all.

RadioButton: A RadioButton consists of several PushButton-like interactors. Only one of them can be set at any time. When the user clicks on a RadioButton, it will be set, and the previously set button will be reset. The author of a lesson can specify a set of actions for each RadioButton. The active set for the pressed RadioButton will be executed as soon as the student clicks on it. A typical use of RadioButtons is a Multiple Choice Question with only one valid answer among a number of given choices.

CheckButton: CheckButtons are similar to RadioButtons, but several of them can be set simultaneously. Each CheckButton has its own set of actions. CheckButtons can be used for Multiple Choice Questions with more than one correct answer.

Slider: A Slider is a small icon which can be set to different states like a *RadioDial* or a *ScrollBar*. Sliders mostly have a more complex structure than other interactors. A slider may consist of several interactors of other types (see the Scrollbar in Figure 3 for instance). Sliders come in two variations: *discrete* and *continuous*. A discrete Slider has actions associated with each of its possible states, whereas a continuous Slider returns a numeric value between author-defined boundaries.

ScrollBar: A ScrollBar is mainly used for scrolling in text documents but can also be used for adjusting any analog value which does not have to be set to an exact number.

RadioDial: A RadioDial is similar to a ScrollBar in its functions.

Text: An interactor of type Text allows the user to enter simple texts. This is the basic interactor for a number of derived interactors which interpret the entered text in a certain way (e.g. analysis of free text answers which is not covered in this paper).

GeneralText: The GeneralText interactor allows the student to enter a text string.

RealText: The RealText interactor allows the student to enter a real number. The number is checked against validity.

IntegerText: is used for integer numbers, IntegerText is similar to RealText.

Timer: A Timer is used for clock functions. A *new* message to the Timer interactor starts an internal stop watch. This value can be used for time-outs, i.e. after a certain amount of time a set of actions is executed which for example gives the student some hints about the problem or ends the problem because the time assigned to it has run out. Another useful application for the Timer interactor is the possibility to send messages which are to be posted periodically.

Record: When the Record interactor is opened (*new* message) recording starts and all messages are stored in a list. This list can be played back at any later time. Previously stored playback lists can be accessed and can show a confused student the solution to a problem by showing step by step the correct way to the end of the problem. Recording can be interrupted by setting the interactor to asleep.

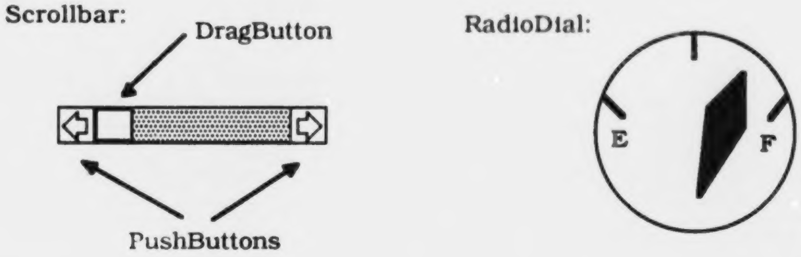

Figure 3.

The Itemlist

Description of the Itemlist. Two different steps are necessary to make an interactor available in a lesson: the first step is the *definition* of the interactor, the second one its *activation*. To activate an interactor means to allow the student to use the interactor according to its type (e.g. to click on it if it is a PushButton). It is the same as setting the state of the interactor to awake. When creating a frame (a frame is a part of a lesson) it is important that the author keeps track of the interactors and their order. The *itemlist* gives an overview of all objects of a frame. Besides mainly graphical and textual objects the itemlist contains information about the interactors that are used in a frame, i.e. which interactors are defined and when they can be activated. All objects belonging to a frame are shown as a linked list of small rectangular boxes. Each box indicates the corresponding entity. The left part of Figure 4 shows a short section of an itemlist.

When a frame is started the execution begins with the first object on the itemlist and continues until all objects have been executed. In case of a graphic object or text the item is displayed onscreen. If the item found in the list is an interactor, its state is set to awake.

Execution stops at the interactor and halts until the student serves the interactor according to its demands, i.e. clicking on a PushButton, moving a DragButton to its destination etc. The interactor is set to asleep and execution continues with the next item of the itemlist. Typically, the first occurrence of an interactor in the itemlist will be its definition. Subsequent occurrences just contain the name of the interactor and only serve to activate it. Automatic activating and deactivating of interactors is not as flexible in dealing with problems. Therefore it is necessary to set the state of an interactor explicitly to the author's demand. How this can be done is described later.

Before we continue with the description of the itemlist we give some more detailed information about the definition of an interactor. The definition includes the following steps:

- choosing the type of interactor: The author can select an interactor from the object-oriented hierarchy which is shown on the screen.
- giving a name to the interactor: Each interactor must have a name which is unique within a lesson. The name is used for an identification of the interactor.
- setting attributes depending on the type of the interactor: The position and the destination of an interactor can be edited directly on the screen by using some kind of simple graphic editor. Position and destination need not be rectangular areas, also polygons may be used. In case of DragButtons graphic objects can be assigned to the interactor which causes the graphic to follow the dragged interactor.
- supplying the names of action-sequences which are to be executed when the interactor is manipulated by the student.

An action sequence is a named group of different primitives, usually graphical and textual objects (see Figure 4). To provide a possibility to create multimedia-like lessons the author can include sound sequences and call external programs (written in C or PASCAL for example) that mainly have the purpose to drive external devices like CD-ROMs or video-players. Finally action sequences may contain messages which are to be sent to other interactors. For example, this technique can be used to set interactors to asleep or to awake, or even to simulate a click on a PushButton. If a new interactor is defined and immediately set to asleep in the action sequence of the *new* message the interactor will not be served and execution will continue with the next item. The interactor will be served only the next time when the execution stops at the same interactor. An action sequence can be named and stored separately on disk.

Let us consider the example of the engine that has to be taken apart. Here, the author would have to do the following things: first, the right type of interactor for the first bolt to be removed has to be picked (we assume that the engine has already been drawn on the screen). Since students should just click on the bolt, a PushButton is the right choice. The author gives a name to it, like *Bolt_1*. Then the position on the screen has to be defined. Finally the author defines the action sequence which describes what happens if *Bolt_1* is clicked on: the drawing of the bolt is erased by placing a filled rectangle on it, and some of the lines that got partially erased are redrawn. This finishes the definition of the interactor.

After all interactors have been defined the author can rearrange the boxes within the itemlist, can perform standard cut/copy/paste operations etc. Interactors can be duplicated, parts of the definition of an interactor (e.g. the destination area of DragButtons) can be copied and pasted to another interactor. Clicking on a box of an interactor opens a window with all types of messages which the interactor can receive (as shown in Figure 4). New action sequences can be linked to the messages or, if there are already existing ones, these actions can be viewed and changed. By clicking on the box twice the definition of the associated interactor is shown and can then be manipulated.

Sequential and Parallel Activation of Interactors. The two examples given at the beginning of this paper show another important aspect of interactors. The interactors are usually activated sequentially, can be manipulated, and fall asleep again. It is nevertheless possible to have several interactors awake at the same time. In the case of the engine all bolts would be active at the same time, giving the student the chance to remove one after the other in arbitrary order. A typical itemlist for parallel activation of interactors is shown in Figure 5: it uses branches from a single item to several others. As soon as the first four PushButtons have been pressed (which corresponds to removing four bolts), the next PushButton can be clicked on (which corresponds to removing the part that was fixed by the four bolts).

The given example expects that each of the interactors in the parallel structure has to be served, i.e. *bolt_1* and *bolt_2* and *bolt_3* and *bolt_4*. However, the author often has to present a problem where several interactors are active simultaneously but only one of them (it makes no difference which one) has to be served, i.e*bolt_1* or *bolt_2* or *bolt_3* or *bolt_4*. Therefore we need an additional structure which helps us to solve the problem. We want to show now that both parallel structures (and, or) are in fact no new structures and that both can be solved very easy by using the messages *awake* and *asleep*. At the beginning all corresponding PushButtons have to be awaked. In the case of the and-structure each PushButton that has been clicked on is automatically deactivated while the other PushButtons still have to wait.

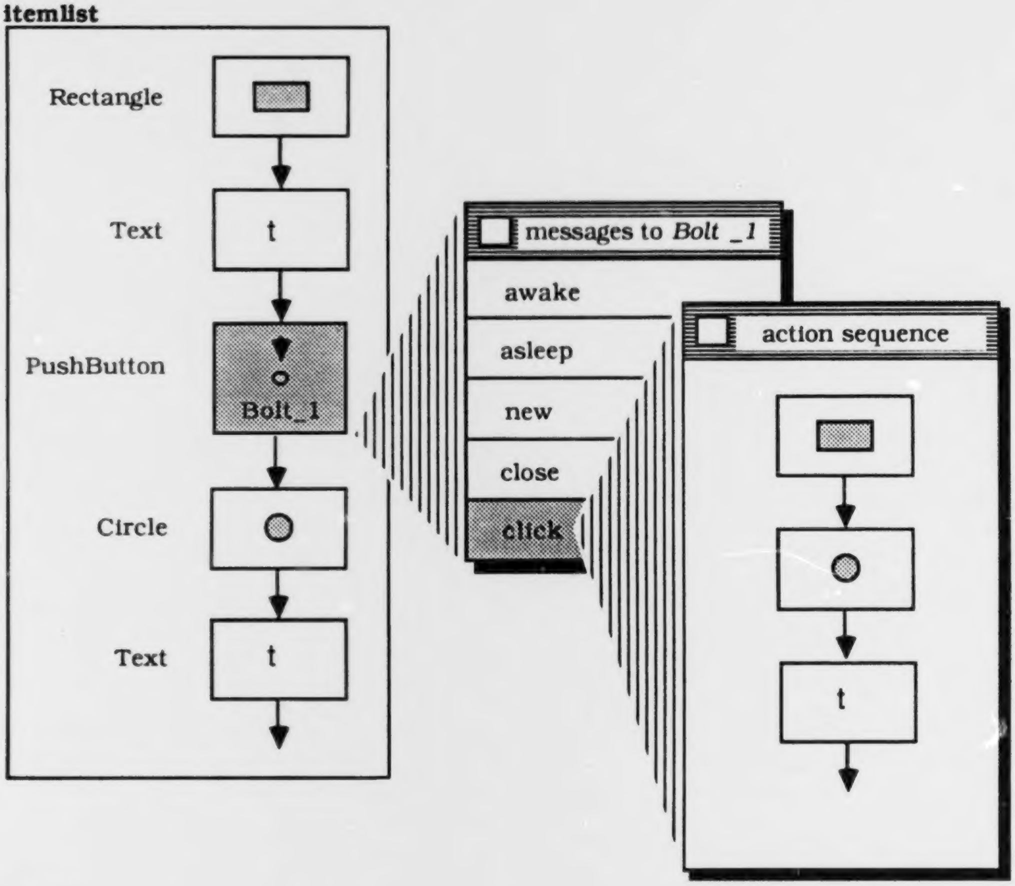

Figure 4.

When all PushButtons have been clicked on no PushButton remains awake and execution is continued with the next item after the parallel structure. In the case of the or-structure the PushButton that has been clicked on is also set to asleep. Additionally, all other PushButtons have to be deactivated with the result that, after the first PushButton has been clicked on, no PushButton of the or-structure remains awake and execution continues with the first item after the or-structure.

Although parallel structures follow simple rules it would be too complicated for the author to set all asleep and awake messages. Hence it is useful for the editing of such structures to use the graphical representation. This simple scheme allows authors to create moderately complex interaction patterns without programming.

Some More Examples

Piano Keyboard. Think of the following problem: Students of music shall be encouraged to train the sensitivity of their ear to different notes. A piano keyboard is shown on the screen and a short melody is played by the computer. The students have to replay the sequence exactly by clicking with the mouse on the piano keys in the right order. Errors are immediately punished with a squeaky tone.

The first thing to do for the author is to draw the piano keyboard on the screen. Afterwards a PushButton has to be related to each of the keys. Each PushButton has a typical tone (with a specific pitch) which is stored in the action sequence. To serve the squeaky tone as well a second PushButton has to be defined for each piano key with an action sequence that plays the squeaky tone. All PushButtons with squeaky tones are set to awake at the beginning, all others except the one which is the first to be clicked on by the student are set to asleep. If the student clicks on the right piano key the tone is played and the interactor is set to asleep afterwards, whereas the corresponding PushButton with the squeaky tone is set to awake. The whole process - that is playing the tone, setting itself to asleep and awaking the other PushButton - must be done by one and the same action sequence. Setting the squeaky-tone PushButton to asleep must be done by the action sequence that belongs to the awake message of the PushButton with the

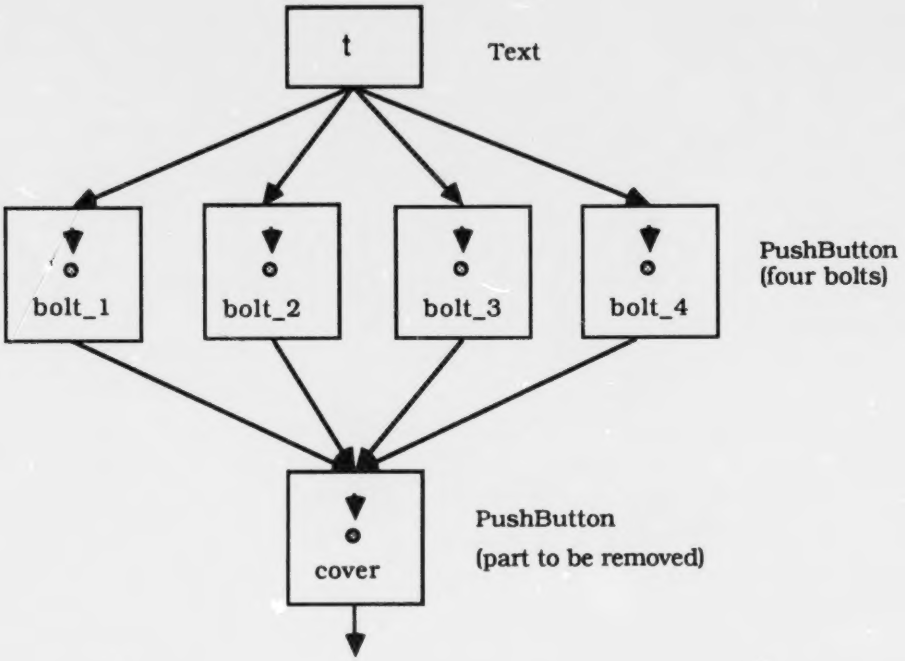

Figure 5.

correct tone. If the interactors are defined that way it is very easy then to create the itemlist. The itemlist is nothing else than a serial list of PushButtons that have to be waked up.

The given example expects that each of the interactors in the parallel structure has to be served, i.e. *bolt_1* and *bolt_2* and *bolt_3* and *bolt_4*. However, the author often has to present a problem where several interactors are active simultaneously but only one of them (it makes no difference which one) has to be served, i.e*bolt_1* or *bolt_2* or *bolt_3* or *bolt_4*. Therefore we need an additional structure which helps us to solve the problem. We want to show now that both parallel structures (and, or) are in fact no new structures and that both can be solved very easy by using the messages *awake* and *asleep*. At the beginning all corresponding PushButtons have to be awaked. In the case of the and-structure each PushButton that has been clicked on is automatically deactivated while the other PushButtons still have to wait. When all PushButtons have been clicked on no PushButton remains awake and execution is continued with the next item after the parallel structure. In the case of the or-structure the PushButton that has been clicked on is also set to asleep. Additionally, all other PushButtons have to be deactivated with the result that, after the first PushButton has been clicked on, no PushButton of the or-structure remains awake and execution continues with the first item after the or-structure.

awake tone c, awake tone d, awake tone a, ...

Assembling an Engine

The second example is similar to our example with the engine that has to be taken apart, only this time it is the other way round: we have a number of single pieces lined up on side of the screen which belong to an engine. What the student has to do now is to take each part and move it to the correct location on the screen, so that at the end we have an engine that would be able to work - with all parts on the right position.

This example is quite simple to manage. The first step would be to define a DragButton for each part which has to be moved, then connect it with the graphical representation of each part so that a bolt or a cover is moved together with the mouse cursor when the DragButton is moved over the screen, and finally define the destination locations for each part of the engine. After a definition of the DragButtons we have a disordered set of interactors collected in the itemlist. The next step would be to order the DragButtons in the itemlist by moving them around and using cut/copy/paste operations, according to the demands of the problem (some pieces may not be moved before other pieces have been placed). In the end the action sequences have to be created and linked to the interactors and the definition of the problem is finished.

Conclusion

We have shown how tutorial lessons can be enhanced using the simple, yet powerful concept of interactors. Students have to be offered an active role in working through lessons: it makes learning more interesting, challenging and would result in better subject understanding. Students can click on Buttons, move DragButtons around, enter texts etc. Depending on the user input action sequences are started. An action sequence can be a textual feedback presented to the student, graphical objects which are drawn onto the screen, or even a short video sequence. To react to user input we used an extendable object-oriented hierarchy of interactors . New interactors with new features can be created which - in connection with modern graphical user interface techniques - give the system more power and flexibility. To give one example of practicable future developments think of the heapsort example once more. Until now the authors had to define each interactor by hand, and they had to know exactly how many numbers had to be sorted. Additional interactors which observe special rules would automatically place the PushButtons on the screen and thus make the heapsort problem independent of the quantity of numbers to be sorted.

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QTA: AN ELECTRONIC TOOL FOR COLLECTION AND ANALYSIS OF TASK EVALUATION DATA

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Abstract

The need for formal, documented training programs is growing at an exponential rate, and most of these programs must be performance based. As a result, we have an extreme need for automated tools that will allow us to make the best use of the limited number of professionals qualified to develop such training programs. In this paper, we describe the development of one such tool, Questionnaire/Task Analysis (QTA) that automates some parts of the job/task analysis process. When provided with an appropriately validated task list, QTA can be used on a computer to administer the questionnaire that allows the job incumbents to evaluate, on a scale from 1 to 5, the **frequency of occurrence**, **importance**, and **difficulty of performance** for each of the tasks on the list. It can then analyze the data collected from one respondent or a group of respondents, according to a decision tree specifically programmed into QTA, to make recommendations about the level of training required for each of the tasks. QTA also prepares a report summarizing the **task list**, the **average frequency**, **importance**, and **difficulty** ratings for each task and the training recommendations for each task.

Introduction

As members of A-6, the Cognitive Systems Engineering (CSE) Group at the Los Alamos National Laboratory (LANL), we recently performed a job/task analysis (JTA) for a group of people responsible for operating the control room of a large building complex used for research on radioactive materials. In this paper, we will refer to this group as the control room operators (CROs). This JTA was to be used to develop a performance-based training (PBT) program for these CROs.

In this paper, we will first discuss in general terms the process of developing a PBT program. Next, we will look more closely at the requirements of performing a JTA, discussing in detail those portions of the JTA process that can be performed using our Questionnaire/Task Analysis (QTA) program. Finally, we will discuss the structure, requirements and limitations of QTA.

Overview of Performance-Based Training Development Process

The process of developing a performance-based training program (see, for example Gagné, Briggs, & Wager, 1988) involves numerous steps, many of which must be conducted in sequence because they form the basis for the next step. The major steps of the PBT development process are listed below.

1. Perform a Needs Analysis - Determine if training is needed to solve existing problems.
2. Perform a Job Analysis - Develop a valid duty area/task list.
    a. Determine what specific duty areas make up the job and what tasks are contained in each duty area;
    b. Produce a validated list of those duty areas and tasks;
    c. Evaluate each task to determine its difficulty, importance, and frequency of performance; and
    d. Analyze the above task evaluation data to determine which tasks require training and at what level.
3. Validate the Task Training Requirements. Using a committee made up of subject matter experts (SMEs), supervisory personnel, and job incumbents, review the task training recommendations from Step 2(d) to verify the level of training recommended for each task.
4. Perform a Task Analysis. For those tasks requiring training, determine the detailed subtasks (i.e., task elements) required to accomplish the task in the proper order, including all conditional branching.
5. Review Existing Training Materials
6. Prepare a Task-to-Training Matrix
7. Establish Terminal and Enabling Objectives for Each Task and Element
8. Generate the Training Materials
9. Evaluate the Training Materials
10. Revise the Training Materials
11. Repeat from Step 1 as Required

A More Detailed Look at the Job/Task Analysis Process

A job/task analysis (Carlisle, 1986) is generally considered to include all of the activities in Steps 2 through 4 above; Steps 5 and 6 can also be included, depending on the status of the training program at the time the JTA is conducted. In the case of a job where no training program exists at the time of the JTA, Step 5 is irrelevant and Step 6 is better performed *after* the training materials are generated.

In this paper we will concentrate on Step 2 above because that is the part of the JTA process that is addressed by our QTA program.

One of the requirements for our JTA was that it had to be conducted according to a Training Accreditation Task

Order recently implemented by the U.S. Department of Energy (DOE) (DOE 5480.18, 1989). This Task Order recommends that the task evaluation process (Step 2[c] above) be conducted by means of a questionnaire. This questionnaire lists the individual tasks and asks the job incumbents to rate the frequency, importance, and difficulty of each task on a scale from 1 to 5. In addition, a zero (0) response is allowed on the frequency rating to indicate that the incumbent never does the task (Definitions of these scales are listed in the appendix). The questionnaire is to be administered to a representative sample of job incumbents and supervisors. The frequency, importance, and difficulty rankings of each respondent for each task are then averaged and analyzed by means of a decision tree to determine the training level required for each task. Three training levels are recognized: no train, train, and overtrain. These terms are defined as follows:

No Train - The task can be learned in the normal course of job activities and, therefore, requires no formal training.

Train - The task requires some type of formal training, which can include on-the-job training (OJT), classroom lectures, computer-based training (CBT), simulation-based training (SBT), etc.

Overtrain - The task is difficult and/or important enough to require training; and, in addition, it is performed so infrequently that the incumbents cannot maintain competence via actual task performance. Therefore, periodic retraining is required.

The decision tree from DOE 5480.18 is shown in Fig. 1, with the break points for each of the three factors (frequency, importance, and difficulty) indicated in the figure. In our experience, the training recommendations resulting from this decision tree analysis are not very intuitive. As a result, we summarize the general frequency, importance, and difficulty characteristic of tasks recommended for each of three possible training levels in Table I. With this background in the JTA process, we start our detailed examination of QTA in the next section.

Purposes of QTA

QTA is a computer program that was developed to perform three primary functions and is appropriately used for a fourth function in some circumstances. Its three primary functions are as follows:

1. Electronically (i.e., using a computer) administer the task evaluation questionnaire and collect and store the data (i.e., Step 2[c] of the PBT process).
2. Analyze the collected data according to the decision tree in Fig. 1.
3. Prepare a Task Training Requirements report according to the recommendations of DOE Order 5480.18 listing the tasks, the average frequency, importance, and difficulty ratings, as well as the training level recommendations, for each task (i.e., Step 2[d] of the PBT process).

As a fourth function, the program can also be used as a data entry and analysis tool in those cases where a printed paper version of the questionnaire must be filled out by hand. We used this method several times and found that entry and validation of the data into QTA is quite time consuming. In addition, our experience to date suggests that even computer-phobic people can effectively use QTA to complete the questionnaire. As a result, we recommend computer administration unless the requisite computer hardware is not available.

Structure of QTA

QTA is written in Modula-2 (LOGITECH, 1987) and runs under DOS (Version 2.0 or above) on any IBM PC, XT, or AT compatible computer that has a color graphics output capability. For QTA to run properly, the DOS ANSI.SYS driver must also be loaded. QTA can run from any floppy disk or from any directory/subdirectory on a hard disk, provided that the data files it requires (see below) are present in the same location. It will write its output files to this same location. The executable, compiled version of the program (QTA.EXE) occupies about 90 kbytes of RAM and requires about 150 kbytes of RAM to execute properly.

The QTA program provides file handling and generation, questionnaire administration, data gathering, data analysis, and report generation functions. To operate properly, it requires two additional ASCII data files: TASKS.DAT and EVAL.DAT. The TASKS.DAT file consists of a JTA title followed by a list of the duty areas with their corresponding tasks. To clarify this discussion, we present the task list for a hypothetical job in Table II and the TASKS.DAT derived from it in Table III. As QTA is presently implemented, there are three constraints on the TASKS.DAT file:

1. The duty area description *must* be on a single line.
2. The task description *must* be on two lines. If there is not enough text to occupy a second line, some character other than a line feed, such as a period, must be entered into the second line.
3. No line of text may contain more than 70 characters (including any item number).

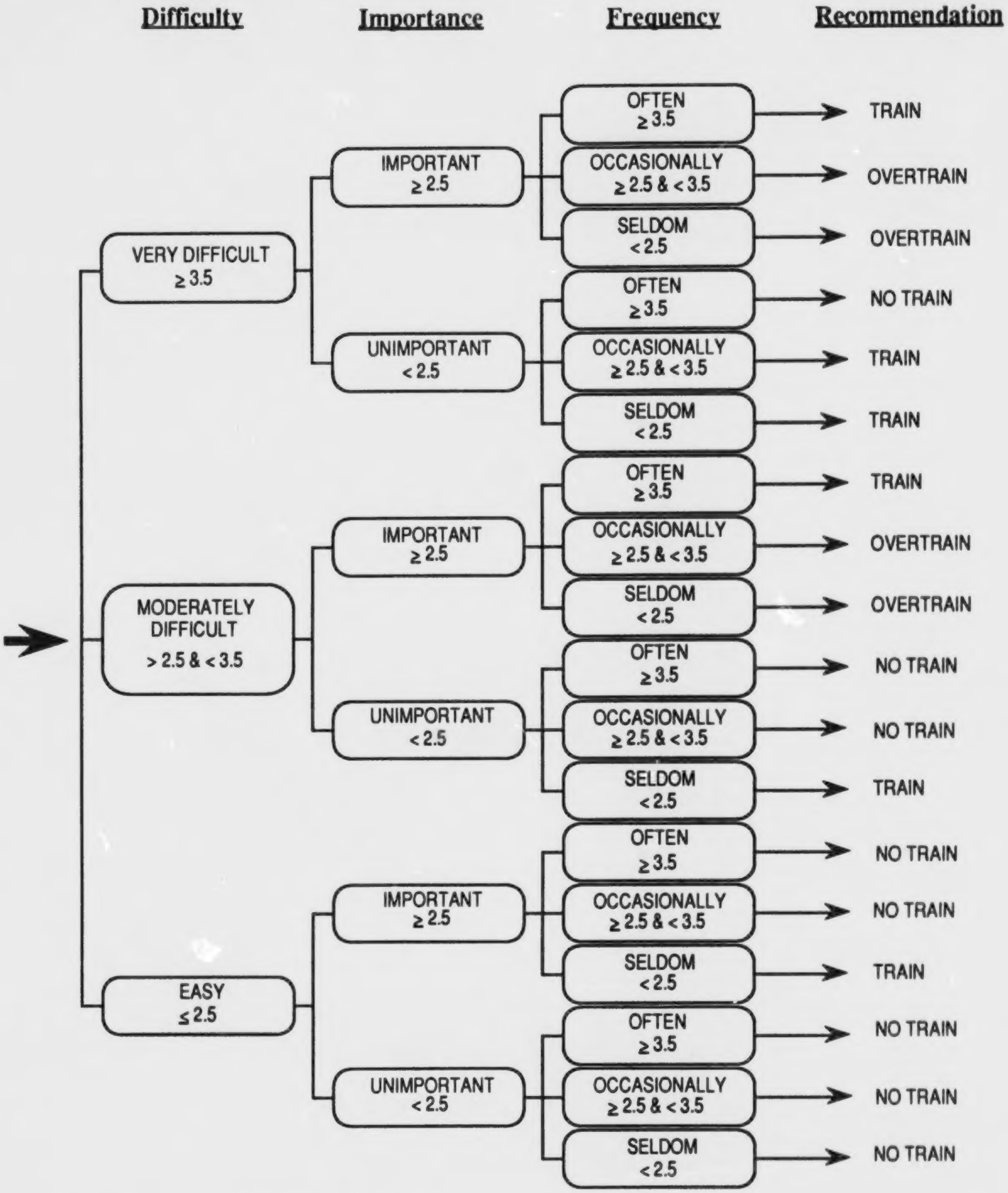
Difficulty
Importance
Frequency
Recommendation
VERY DIFFICULT ≥ 3.5
MODERATELY DIFFICULT > 2.5 & < 3.5
EASY ≤ 2.5
IMPORTANT ≥ 2.5
UNIMPORTANT < 2.5
OFTEN ≥ 3.5
OCCASIONALLY ≥ 2.5 & < 3.5
SELDOM < 2.5
TRAIN
OVERTRAIN
OVERTRAIN
NO TRAIN
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Figure 1. Decision tree used in analysis of questionnaire data.

Table 1. Summary of Decision Tree Criteria and Rating Scales

NO TRAINING IS REQUIRED FOR THE FOLLOWING:*

- Easy tasks unless they are both important and infrequently performed
- Moderately difficult tasks if they are not important and are performed moderately to very often

TRAINING IS REQUIRED FOR THE FOLLOWING:

- Easy tasks that are important and are performed infrequently
- Moderately difficult tasks that are (1) important and performed very often or (2) not important and are performed infrequently
- Very difficult tasks that are important provided they are performed very often
- Very difficult tasks that are not important if they are performed moderately often or only seldom

OVERTRAINING IS REQUIRED FOR THE FOLLOWING:

- Both very difficult and moderately difficult tasks that are important and are performed only moderately often or seldom

*Note: The break points for our rating scales of 1 to 5 were set as follows:

Difficulty	Importance	Frequency
Very	Very	Often
≥ 3.5	≥ 2.5	≥ 3.5
Moderate		Occasionally
> 2.5 & < 3.5		≥ 2.5 & < 3.5
Easy	Not	Seldom
≤ 2.5	< 2.5	< 2.5

The EVAL.DAT file is an ASCII file that describes the structure of the TASKS.DAT file as a linear array of integers. The first integer is the number of duty areas in the TASKS.DAT file, followed in order by the number of tasks in each of the duty areas. A duty area may have zero tasks, which allows the inclusion of subheadings within the report finally generated by QTA (see below). The EVAL.DAT file for our hypothetical task list is presented in Table IV.

Table 2. Task List for Hypothetical Job

102. PROCESS COOLANT SYSTEM
  102.1 Prepare tank car for unloading.
  102.2 Unload tank car.

111. AREA CONTROL ROOM
  111.1 Monitor assay spectrometer
  111.2 Calculate assay
  111.3 Adjust line recorders

Table 3. TASK.DAT File for Hypothetical Job

102. PROCESS COOLANT SYSTEM
102.1 Prepare tank car for unloading
102.2 Unload tank car.

111. AREA CONTROL ROOM
  111.1 Monitor assay spectrometer.to
determine background.
  111.2 Calculate assay.
  111.3 Adjust line recorders.

Table 4. EVAL.DAT File for Hypothetical Job

Job Analysis for Hypothetical Job

1
2
3

When the questionnaire is administered by QTA, it builds two data files. The first of these is an ASCII listing of the respondent's frequency, importance, and difficulty ratings for each task. In our present version of QTA, this file is named **employee number.cat** where "employee number" is the employer-assigned number of the respondent and "cat" is a three character extension representing the employee category, either operator (OPR) or supervisor (SUP) in the present version of QTA. The second file built by QTA is FILELIST.DAT, which is simply a list of the respondent questionnaire data files generated by the program.

Operation of QTA - Questionnaire

When QTA is first started, it requires the respondent to choose from four possible functions to be performed, namely the following:

1. Complete the "long form" of the questionnaire.
2. Complete the "short form" of the questionnaire.
3. Analyze the results.
4. Exit the program.

If either option 1 or 2 is chosen, the program then collects demographic data from the respondents, including their name, employee number, job title, section, employee category, years of experience, and education. All of this information is entered into this respondent's data file. Then QTA administers the actual questionnaire by presenting the tasks one by one, in order. For each task, the duty area is listed at the top of the screen followed by the description of the task, both obtained from the TASKS.DAT file.

If the "long form" was chosen, three individual, consecutive screens are generated for each task to obtain the level ranking for each of the evaluation factors (i.e., frequency, importance, and difficulty) for the displayed task. This format allows enough room on the computer display screen to provide on-screen definitions of the rating scales. If the respondent enters a zero for frequency on the first screen, the importance and difficulty screens for that task are skipped and QTA goes on to the next task. The advantage of the long form is that the definitions of the evaluation scales are on the screen with the task description, eliminating the need for a printed reference. The disadvantage is that the respondent must view more screens than if he had chosen the short form (see below).

If the respondents choose to complete the short form of the questionnaire, they are first presented with a screen that asks whether they ever do the task. If they respond with a *yes*, they are presented with a single screen that requests the level ranking for all three evaluation factors. Because of space limitations on that screen, the short form does not provide rating scale definitions on the screen. As a result, when using the short form, we must provide the respondents with printed listings of the scale definitions for all three evaluation factors.

Actually, when QTA is used to administer the questionnaire on the computer, we recommend that the respondents be provided with printed copies of both the task list and the definitions of the rating scales, regardless of whether the long or short form is chosen. The printed task list enables the respondents to ascertain the relationships among tasks and duty areas. The printed rating scales are used as a reference to help clarify the rating choices.

As described above, the data collected by QTA are stored in convenient ASCII files; as a result, they can be analyzed by tools other than QTA, such as spread sheets, data base management programs, etc.

Operation of QTA - Data Analysis

As described above, QTA creates an individual data file for each person completing the questionnaire; these questionnaire data files are used in the analysis phase to be discussed now. QTA also keeps a list of these individual data files it has created in the FILELIST.DAT file. This latter file is also accessed during the analysis portion of the program to determine which questionnaire data files to include in the analysis.

As presently implemented, QTA allows two job types to be entered during the demographic data collection of the questionnaire; these are operator or supervisor. As a result, the questionnaire data files it constructs are of two types, namely *.OPR or *.SUP. When QTA starts, if the ***analyze*** function is chosen from the opening screen, the analyst is given the choice of analyzing the data from the operators, the data from the supervisors, or the combination of both sets of data to determine the training recommendations resulting from the decision tree analysis. The data from the appropriate files are then used to compute the numerical averages for each of the rating factors of each task. These average rating factors are then analyzed using the decision tree to obtain the corresponding training recommendations. After the analysis is completed, QTA creates an analysis file. This file includes a header with the name of the survey; the category of questionnaire data files analyzed; and for each task, the task name, the averages of the frequency, difficulty, and importance ratings, and the recommendation for the training level for that task. An output file for our hypothetical job is presented in Table V, literally the computer output.

The analysis files for the separate data sets (i.e., supervisors, operators and all respondents) should be compared to establish the validity of the recommendations. Because QTA uses an ASCII file, FILELIST.DAT, to define which questionnaire data files are averaged for any single analysis, the analyst may edit that FILELIST.DAT file to include or exclude individual questionnaire data files from any particular analysis. Thus, if any single individual's responses differ greatly from the responses of his peers, the effect of that individual's data on the analysis of the averaged results can be explored by running the analysis first including and then excluding that data file and comparing the results.

Again, as mentioned above, the analyst can easily access the individual files with a word processor or ASCII editor and then use the files with other analysis tools, such as spread sheets, data base management systems, etc.

Limitations of QTA

QTA has several limitations. One limitation of the current version of QTA is that the decision tree logic used in the data analysis is "hard wired" into the program at the Modula-2 code level. If someone wants to use the program with different break points or with a different logic in the decision tree, it is necessary to make those changes in the original Modula-2 source code.

Table 5. Task Analysis Report Output From QTA for Hypothetical Job

```
-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*- JOB ANALYSIS TABULATION -*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-

        Job Analysis for Hypothetical Job; ALL PERSONNEL

        Compiled By:______________________________

        Verified By:______________________________ Date :____________

        Rated By   :______________________________ Date :____________

        TASKS                                   DIFF        IMP          FREQ
        Comments

        102. PROCESS COOLANT SYSTEM

        102.1 Prepare tank car for      1.67        4.00        3.00         No Train
        unloading

  102.2 Unload tank car                 2.33        4.00        3.33         No Train

     111. AREA CONTROL ROOM

     111.1 Monitor assay spectrometer   2.33        4.67        3.67         No Train
     to determine background.

     111.2 Calculate assay              2.67        5.00        4.00         Train

     111.3 Adjust line recorders        1.33        3.67        2.67         No Train

                                        Number of Surveys   3
```

Another limitation is that there are minimal undo and back-up capabilities. When respondents enter their frequency, importance, and/or difficulty ratings, they can use the backspace key or the space bar (depending on the situation) to change their responses. However, once they depress the ENTER key, they cannot go back and change their responses.

Finally, when respondents are completing the questionnaire, they must finish the entire task list. There is no mechanism for stopping in the middle and then resuming at that place later. As time permits, we plan to rectify some or all of these shortcomings.

What QTA Does Not Do

QTA is an automated tool that was developed to quickly and efficiently perform several of the steps required in a complete JTA. It administers the task evaluation questionnaire, analyzes the questionnaire data *according to one specific paradigm and criteria set*, and prepares a formatted report summarizing its training recommendations. However, this is all that it does. *It does not do* the following:

- Generate the task list,
- Validate the task list,
- Examine/compare the questionnaire data sets for reasonableness, thoughtlessly entered ratings, cooperative responses, overinflation of job importance, etc.,
- Validate the training recommendation list,
- Perform the detailed task analysis,
- Etc.

Anyone planning to use QTA should always keep in mind its limitations. It is, after all, just a "dumb" computer program, subject to the usual GIGO syndrome. If it is fed garbage, either in the form of assumptions or as data, its product will most assuredly also be garbage!

Conclusions

We are now in the process of doing our third job analysis using QTA. Although it does have some limitations, we have found it to be an excellent tool for administering task evaluation questionnaires and analyzing the resulting data. Most of the problems we have encountered were related to the difficulty of clearly communicating to the respondents the meaning of the rating scale values, especially for the importance factor. We plan to summarize our experiences in this area in another paper to be prepared soon.

Acknowledgments

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Appendix - Definitions of the Task Rating Scales

0. NEVER do this task
1. Less than once a year
2. Once every 5 to 12 months
3. Once every 3 weeks to 4 months
4. Once every 1 or 2 weeks
5. More frequently than once a week

The importance scale is rated in terms of the consequences of improper performance in the following impact areas:

- Impact to the environment
- Consequences to your health and that of others on the job
- Security infractions
- Violation of LANL or ANSI standard procedures and/or DOE or DOT regulations
- Quality and quantity of job accomplishments

The importance scale ratings are listed below:

1. MINIMAL - Violates standard procedures and/or regulations, but there are no consequences in other impact areas.

For example: Improper task performance results in a security regulation violation, but the task is accomplished this time with no breach of security.

2. UNDESIRABLE - Violates standards and/or regulations resulting in minimal consequences to some or all of the impact areas.

For example: Improper task performance may result in a dose considered inconsistent with the "as-low-as-reasonably-achievable" (ALARA) philosophy, or there is potential environmental impact.

3. SERIOUS - Results in significant consequences to some or all impact areas.

For example: Improper task performance may result in personal injury, but the injured person can return to work, or there is material and/or equipment damage requiring significant corrective action.

4. SEVERE - Results in severe consequences to some or all impact areas.

For example: Personal injury occurs that requires hospitalization, the environment is contaminated, or material and/or equipment damage occurs requiring costly and extensive corrective action.

5. EXTREMELY SEVERE - Results in the most severe consequences in some or all areas.

For example: A criticality accident occurs; there are fatal injuries to personnel; or the facility is shut down because of equipment, facility, or environmental damage.

The difficulty scale ratings are listed below:

1. Very easy to perform
2. Somewhat easy to perform
3. Moderately difficult to perform
4. Very difficult to perform
5. Extremely difficult to perform

MACHINE-READABLE COURSEWARE MODULES FOR INTRODUCING EXPERT SYSTEMS

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Abstract

This paper describes teaching materials designed for courses in which a portion, but not all of the time, is devoted to expert systems. Knowledge representation, backward chaining, confidence factors, multi-value variables, knowledge engineering, induction, and shell evaluation are covered. A 56-file disk with class handouts, assignments, solutions, and knowledge bases for assignments and demonstrations is available from the author.

Artificial intelligence pioneer Allen Newell has stated that "there is no doubt, as far as I am concerned, that the development of expert systems is the major advance in the artificial intelligence field during the last decade (Newell, 1987)." Newell was speaking from a scientific standpoint, but he also acknowledges that expert systems "has been the main driver of the current wave of commercialization of AI." If Newell's assessment is correct, expert systems should be included in the curriculum.

This paper begins by tracing the evolution of expert systems from research to the personal computer. Next we discuss the place of expert systems in the curriculum. Finally, we describe machine-readable teaching materials developed for introducing expert systems.

Background

Expert systems trace their roots to the foundations of formal logic, and early attempts to automate deduction. When computers became available, pioneers like McCarthy (1960, 1988) claimed that we should concentrate our efforts on representing knowledge, letting an automatic reasoning program draw relevant conclusions. At the same time, Herbert Simon and Alan Newell began trying to capture expert's strategies in programs. They recorded "protocols" of graduate students thinking aloud while proving theorems, then wrote programs called the Logic Theorist (Newell, 1963) and General Problem Solver (Newell, 1963) which applied the same sort of pattern-matching and difference-reducing heuristics as the students.

The forerunners of modern expert system shells (development environments) were developed at Stanford University. First came DENDRAL (Lindsay, 1980), a program for enumerating the set of feasible molecular structures of a chemical compound given spectrograph input, and trying to decide which structure was most likely correct. Several systems were inspired by DENDRAL, including MYCIN (Shortliffe, 1976), a program to aid in the diagnosis and treatment of meningitis and bacteremia infections, given input from a physician. The first shell was EMYCIN (Buchanan, 1984) (Essential MYCIN) which separated the MYCIN inference program from the knowledge base of diagnostic heuristics. EMYCIN was MYCIN with the domain-specific knowledge removed, so some call it "Empty MYCIN."

These early expert systems and shells required large computers and projects, but that is no longer the case. Today, there are several shells which are practical for development and delivery on standard, 640 KB, MS-DOS computers (Press, 1988). One of these, Texas Instrument's PC Plus is based on EMYCIN.

The feasibility of low cost expert systems is illustrated by the experience of Ed Mahler, Director of the Artificial Intelligence Division at Du Pont (Mahler, 1990). Du Pont has deployed over 200 expert systems. Each is quite small (averaging 80 production rules), but Mahler estimates the aggregate savings to Du Pont as $40 million annually. It is noteworthy that these systems are not implemented by staff programmers, but by end users who take a two-day training class and are supported by Mahler's department.

Expert Systems in the Curriculum

Since expert system technology is becoming widely available, a full-semester, elective course in expert systems is justified for computer science (CS) and computer information system (CIS) majors. Bahill and Ferrell (Bahill, 1986) at the University of Arizona have taught and written about such a course. In addition to teaching useful skills, the course is a good introduction to declarative programming. Expert system shells allow students to rapidly develop meaningful programs, so the declarative programming "forest" will be clear without examining too many "trees."

Expert systems may also be taught as a portion of an Introduction to Artificial Intelligence (see, for example, the ACM model curriculum course CS 12 (Austing, 1979)). Most texts for the Introduction to Artificial Intelligence course include a discussion of expert systems, for example (Charniak, 1985). This course also typically introduces list and declarative programming concepts with Lisp or Prolog exercises. The relatively low level of these languages and the amount of material which must be covered in the course restrict the programming exercises to simple examples. More comprehensive assignments are feasible in a limited time when using an expert system shell (Koster, 1988).

Expert systems are also relevant in an Introduction to Decision Support Systems (see, for example, the DPMA model curriculum course CIS/86-11 (DPMA, 1986)), as evidenced by texts such as Doherty and Leigh (Leigh, 1986). This course typically focuses on techniques and tools, with no programming. Here again, expert system shells enable us to introduce programming exercises in the limited time available.

A module on expert systems might also be appropriate in a cognitive psychology course or in course in a field in which there are substantive applications of expert systems. For example, an expert systems module is part of a pre-law course, offered in the sociology department at our university.

With these needs in mind, we developed material for an expert system module which can used as part of a course or as the beginning of a course dedicated to expert systems. The material has been tested in a Decision Support Systems course for MBA students. In addition to expert systems, that course covered optimization techniques, simulation, spreadsheet modeling, project management, statistical forecasting, executive support systems, and group decision support techniques.

Machine Readable Teaching Materials

All of the material described below is available in machine-readable form, so that it may be easily copied and edited. The distribution disk contains handouts, homework assignments, knowledge bases for assignments and demonstrations, and solutions to assignments.

Programming assignments and examples use the VP Expert (Paperback Software) shell. VP Expert is compared to several other shells in Press (Press, 1988), and found to be suitable for instructional assignments. Sondak (Sondak, 1986), reaches the same conclusion. Other commercially available shells would have been as good, but none were as reasonably priced.

The topics covered are knowledge representation and backward chaining, confidence factors, multiple values for variables, knowledge engineering, induction, and shell evaluation. Let us begin with knowledge representation and backward chaining.

Knowledge Representation and Backward Chaining. The first set of demonstration knowledge bases, handouts and assignments introduce the basics of knowledge representation and automatic inference using backward chaining. Six simple knowledge bases, FOOD1-FOOD6, are used to illustrate these basic concepts as well as some of the VP Expert user interface options. They are used for in-class demonstration and discussion and for assignments.

Figure 1 is a listing of FOOD1.KBS and Figure 2 traces its execution. FOOD1 illustrates the procedural *action* section, rules, and declarative statements of VP Expert knowledge bases. The four rules are easily traced in class and in a handout, providing an illustration of backward chaining. The file FOODTRC.HDT is a handout explaining the execution trace of FOOD1.

FOOD2 through FOOD6 are variations on FOOD1, illustrating the VP Expert keywords and statements: *because, display, autoquery, runtime, ask/choices*, and *endoff*. The following shows which constructs are used in each:

FOOD1: runtime, ask/choices, display
FOOD2: runtime, ask/choices, endoff, display
FOOD3: runtime, ask/choices, display, autoquery
FOOD4: runtime, ask/choices, because, display
FOOD5: ask/choices, display
FOOD6: autoquery, runtime, display

The ideas of declarative programming and backward chaining are new to most students, so the distribution disk contains two assignments requiring them to trace knowledge base execution and to work with the VP Expert editor and user interface.

In FOOD1-FOOD6, all variables are boolean or character strings, much like those in a procedure-oriented language. However, variables in a shell differ from those in procedure-oriented languages in that they have varying degrees of certainty and they may assume more than one value. The materials in the following two sections illustrate each of those differences.

Confidence Factors. Confidence factors are illustrated by a handout, an assignment, and seven knowledge bases for use in class demonstrations. The first demonstration knowledge base CNF.KBS shows how to input confidence factors and shows the value of the truth threshold for confidence factors. The next two, CNFOR and CNFAND, demonstrate the affect of disjunctive and conjunctive conditions in the *if* portion of a rule. CNFOR is documented in CNF.HDT, a handout which can be used along with the demonstration.

Three other knowledge bases, CNFPROB, CNFPROR, and CNFPRAND, are used in class demonstrations to illustrate the affect of confidence factors in the *then* portion of rules. CNFPROB is simplest, using a single variable rule, so it is demonstrated first. CNFPROR and CNFPRAND add disjunction and conjunction to the *if* portion of the sample rule.

CNF.AST is a three part assignment on confidence factors. The student first experiments with conjunction and disjunction in the *if* portion of rules, then with confidence factors in the *then* portion of rules.

Multiple Values for Variables. Shell variables also differ from those in procedure-oriented languages in that they can assume many values. There are two knowledge bases and a handout illustrating the idea of plural-value variables. They are variations on FOOD1. In FOODPL1, all three variables are plural; in FOODPL2 only FOOD and WINE_COLOR are plural. These are explained in a handout file.

Knowledge Engineering. Once the students are familiar with the shell, we turn to a knowledge engineering. In addition to theoretical discussion, the students do three three rapid prototyping assignments:

KE1: The first of three, graduated knowledge engineering exercises in which the student builds a quick prototype of an expert system for selecting DBMS.

KE2: The second knowledge engineering exercise in which the student revises and elaborates upon the prototype built in the first.

KE3: The third knowledge engineering exercise in which the student adds database access to the knowledge base built in the first two. A small DBF file accompanies this assignment.

The assignments are worded as "interviews" between the domain expert and knowledge engineer, and the student is asked to implement a prototype of the system. Figure 3 shows the interview from the first knowledge engineering assignment. The full assignment file contains some sample runs and further instructions to the student.

The second knowledge engineering assignment elaborates upon the first, and students having difficulty adapting their thinking from procedural to declarative programming find the assignment difficult. For those students, we have included another optional exercise, QUERY.AST, designed as a warm-up for the second knowledge engineering assignment.

The third knowledge engineering assignment extends the second by adding database access. It can be accompanied by discussion of expert systems components in larger systems, interfacing to real-time instruments, and shells such as PC Expert Professional (Software Artistry) which make provision for knowledge bases embedded in conventional programs.

Induction. VP Expert also has a simple induction capability. In the assignment KEINDUCE, the students use the same situation as KE1, but solves it by induction instead of writing rules. This example is used after the knowledge engineering assignments, and it illustrates induction and gives the students a chance to compare induction and rule writing. Figure 4 shows the induction table (decision exemplars) used to generate the solution knowledge base.

Shell Evaluation. The final module covers shell evaluation. There are many factors to consider in evaluating a shell. We discuss the factors shown in Table 1 in the course, and assign reading on shell evaluation (Firdman, 1986, Shepard, 1987, Olsen, 1987, Citrenbaum, 1988). Additionally, students are given an assignment in measuring shell efficiency using a benchmarking technique we have developed (Press, 1989).

The benchmarking approach uses a program to generate test benchmarks of a given size. The course materials include source and object code for benchmark generating programs for the VP Expert and M1 shells. Handout files with instructions for using the benchmark generators are also included.

There is a benchmarking assignment in which the students are asked to generate some test knowledge bases and time their execution. The student also experiments to see how large the knowledge bases are and how much memory they require.

Conclusion

The teaching material described above has been tested in an MBA course, and revised in accordance with that experience. A 56-file disk containing the class handouts, homework assignments, knowledge bases, and solutions to assignments is available from the author. In requesting it, please send a formatted disk (3 or 5 inch) in a self-addressed, stamped mailer.

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Figure 1: A Listing of FOOD1.KBS

```
ACTIONS
     DISPLAY "LET'S DECIDE WHAT SORT OF WINE TO DRINK WITH YOUR MEAL.
PRESS ANY KEY TO BEGIN THE CONSULTATION.~"
     DISPLAY ""
     FIND WINE_COLOR
     DISPLAY "YOU SHOULD HAVE {WINE_COLOR} WINE WITH YOUR {MEAL_TYPE}."
;
RULE 1
     IF MEAL_TYPE = MEAT
     THEN WINE_COLOR = RED;
RULE 2
     IF MEAL_TYPE = FISH
     THEN WINE_COLOR = WHITE;
RULE 3
     IF FOOD = HAMBURGER OR
        FOOD = STEAK OR
        FOOD = HOTDOG
     THEN MEAL_TYPE = MEAT;
RULE 4
     IF FOOD = LOBSTER OR
        FOOD = SHRIMP OR
        FOOD = SALMON
THEN MEAL_TYPE = FISH;

RUNTIME;
ASK FOOD: "WHAT ARE YOU GOING TO EAT?";
CHOICES FOOD: HAMBURGER,STEAK,HOTDOG,LOBSTER,SHRIMP,SALMON;
```

Figure 2: Trace of FOOD1.KBS

```
Goal: FIND WINE_COLOR
    Invoke RULE-1 (because it sets WINE_COLOR)
            Invoke RULE-3 (because it sets MEAL_TYPE)
            seek FOOD
            FOOD = "lobster" (input by the user)
        RULE-3 fails
        Invoke RULE-4 (because it also sets MEAL_TYPE)
        RULE-4 succeeds, so MEAL_TYPE = "fish"
    RULE-1 fails
    Invoke RULE-2 (because it also sets WINE_COLOR)
    RULE-2 succeeds, so WINE_COLOR = "white"
Display WINE_COLOR = "white" to the user
```

Figure 3: Setting for the First Knowledge Engineering Assignment

You are a knowledge engineer (KE) assigned to build an expert system to help recommend data management software to people coming into computer stores. Your domain expert (DE) is the owner of the largest Computerland store in town. You interview him to see how he helps customers choose a data management software package:

KE: How do you decide which data management program to recommend?

DE: Well, first off I find out whether they need a DBMS or whether they can get by with a file manager.

KE: How can you determine that?

DE: I just ask if they have applications where information from multiple files must be brought together. If the answer is "yes," I know that they need a DBMS. If it is "no," I know they can get by with a simpler and cheaper file manager.

KE: I see. Well, what do you do next?

DE: That depends. If they only need a file manager, it's simple. We carry three file managers: FM1, FM2, and FM3FM3 is my favorite but it can only handle files that will fit in memory up to around 1,000 records. If their largest file will be under 1,000 records, I recommend FM3.

KE: But what if they have larger file?

DE: Well, FM1 is a powerful program, but it takes some sophistication on the customer's part. If he or she is an experienced user, I recommend FM1, but for beginners, I suggest FM2.

KE: Okay, that takes care of the file managers, but what if the customer has multiple file applications and needs a DBMS?

DE: Well that's pretty straight forward too. We carry three DBMS programs: DB1, DB2 and DB3, so it's just a matter of choosing one of them. In choosing among them, I go back to customer sophistication. A highly sophisticated customer can use DB1 which is the most powerful. If the customer is experienced, but not an expert, I suggest DB2, and recommend DB3 for a beginner.

KE: Okay, I think I have the idea. Let me work up a prototype version of the program. I'll show it to you next week.

Figure 4. An Induction Table for the Situation in Figure 3:

Mult Files	Filesize	Expertise	Dbase
no	<1000 records	*	FM3
no	>1000 records	beginner	FM2
no	>1000 records	*	FM1
yes	*	highly sophisticated	DB1
yes	*	experienced	DB2
yes	*	beginner	DB3

Table 1. Factors to Consider in Shell Evaluation

The User Interface
- Can the shell explain how it came to a conclusion?
- Can the shell explain why it is asking something during a consultation?
- Will the shell display help to the user?
- Are there flexible prompts and menus for user input?
- Is there data type checking?

The Developer Interface
- Is the KB entered with an external or built-in editor?
- Is the internal editor fast and powerful?
- Are there debugging aids?
- Is there a playback capability?
- Is there an induction capability?

The Language
- Are certainty factors allowed?
- Is forward chaining possible?
- Can the shell read and write external files and devices?
- Can the knowledge engineer control the consultation sequence?
- Can you write subroutines and functions in an external programming language?
- Are frames supported?

Efficiency
- How fast are loading and execution?
- How much disk storage does the KB require?
- How large a KB can be executed?
- How large a KB can be loaded into memory?
- Will the program use extended memory if you have it?
- How fast is development?

Company Policy
- Can you create run-only versions of the finished KB, and is there a license fee?
- Is the company marketing the shell committed to support and ongoing development?
- Is there an upgrade path?
- How much does the program cost?

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Selected Formal Papers from the

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THE USE OF COURSE OF ACTION TO DEVELOP FIVE UNITS OF INSTRUCTION IN A CARDIOVASCULAR SYSTEMS COURSE

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Abstract

Course of Action was used to create five units of computer assisted learning in cardiology. The material was offered to medical students as part of the planned learning experiences. A thorough evaluation of the authoring tool was undertaken. The merits and limitations of the system will be presented along with helpful hints to prospective users.

Introduction

In 1986 the new authoring system called "Course of Action" was introduced at the Development of Computer-Based Instructional Systems (ADCIS) 28th International Conference in Washington, D.C. Many educators were excited about the potential of reducing the time and effort required to develop quality computer assisted instructional (CAI) materials. The system has now been available of four years; however, there are few evaluation reports outlining its advantages and disadvantages. This paper shall outline its use in a medical undergraduate course and summarize the system's main advantages and disadvantages.

Course of Action

Jesse M. Heines (1987) describes "Course of Action" as the most advanced authoring system you can buy. Its power and simplicity support more effective authoring procedures and better instructional interactions. Some of the advanced features include: direct editing, great graphics, data-driven animation, talented text, advanced answer analysis, concurrency, interactive video, individualized branching, electronic student notebook, models, variables, computer-managed instruction, external interface, portability, local languages, and automatic documentation. But, from a practical prospective what are its true advantages and disadvantages? This evaluation is based upon personal experience obtained in creating five units of instruction in cardiology. The program offers approximately three hours of individualized instruction. The CAI materials were tested with first year medical students as part of the instruction offered in a course entitled The Cardiovascular System. The structure of the CAI program is described below.

Program Structure

Purpose of CAI materials. The goal of the project was to develop and evaluate a CAI program using Course of Action. Cardiac malformations from an interdisciplinary perspective were selected to test the many features offered by Course of Action. The target audience were first year medical students but the materials were also seen to be suitable for post-graduate students.

The majority of CAI materials available today are discipline based (e.g. the anatomy of the heart, cardiac physiology, cardiac radiology). The curriculum in the Faculty of Medicine at the University of Calgary is arranged according to body systems and taught using a multidisciplinary approach. Thus, the single disciplinary CAI packages identified were inadequate since they did not integrate knowledge and skills across disciplines.

In designing the CAI course, basic science concepts from the disciplines of Anatomy, Physiology and Pathology were combined with the clinical science disciplines of Cardiology and Radiology. This integrated information parallels that required to make an accurate diagnosis in clinical practice.

Five common congenital heart defects were selected (Atrial Septal Defects, Ventricular Septal Defects, Transposition of the Great Vessels, Patent Ductus Arteriosus and Tetralogy of Fallot). For each of the five defects, the student is presented with a menu offering the following options:

- Normal development
- Abnormal development
- Diagnostic skills
- Knowledge Quiz

Each of the above four sections are independent of each other allowing the students to choose an individual pathway through the materials according to personal needs. For example, on the first attempt, the novice student may examine all four sections within a given congenital heart defect in the above defined order. On further attempts, the same student may be more selective and go into specific sections while bypassing others. This arrangement makes it of equal value to more senior students including interns and residents who may wish only to "brush up" on their diagnostic skills.

Since most of the concepts required to master the material are visual and auditory, each defect is presented with a minimum of textual information with the emphasis placed on animations of heart growth (both normal and abnormal), static images (both schematic such as plots and real images such as X-rays), and graphic flow diagrams (e.g., to demonstrate pressure and oxygen levels in different conditions along with corresponding simulated heart sounds).

To permit discriminative use, the normal and abnormal development sections contain up to six nested levels of information, with level one representing general "overview" and each higher nested level containing progressively more detailed information. The section on normal development takes the student through a series of logical progressions related to a specific defect on how that portion of the heart normally forms. The abnormal development section provides the student with the information regarding known mechanisms and underlying causes of the defect plus the physiological consequences of the defect. In the diagnosis section the student is exposed to various diagnostic techniques including electrocardiograms, phonocardiology, and radiology as they relate to the defect in question.

The knowledge quiz section integrates the core knowledge from the normal, abnormal, and diagnostic sections. This section represents a classic questions/answer format tutorial. However, where appropriate, all the other sections contain opportunities for student interaction. For example, in the normal development section, students are required to choose between several possible scenarios on how a selected region of the heart develops. Each scenario is taken to its end point, with the student being given feedback of where they made logic errors or where they require more information to continue.

In the knowledge quiz section, students are also offered a patient simulation to test their diagnostic skills. After reading a case history of the patient, the student is asked a series of questions, the responses to which are added to a diagnostic chart. The process continues until the student is able to diagnose the patient's problem.

Analysis

Direct editing. Changes or additions to courseware can be make while being presented in student mode. Tools to make changes and additions will appear immediately when the edit mode is executed. Changes are made directly on the screen and when completed the author can re-enter student presentation mode.

Graphics. The program comes with a restricted graphics package which is primarily useful for creating boxes for highlighting text or flow diagrams. The majority of images we utilized had to be created with a separate graphics package such as MacPaint or digitized with a scanner from drawings or pictures. However, using the copy/paste function or "import graphics" feature which takes you out to a graphic application and back without having to exit the authoring system makes graphic handling a fairly efficient process.

Data-driven animation

Talented text. Full word-processing power is available for text presentation. It is possible to position text anywhere on the screen. There is a wide variety of text styles, text fonts, and text sizes. As with most text processors, margins, tabs, and decimal tabs can be adjusted. Text automatically wraps around at margin settings as you type.

Answer analysis. There was no need to limit students to multiple-choice questions. Extensive interaction capabilities are available: text entries, mouse actions, pulldown menus, on screen push buttons, and function keys are available in any combination.

Time limits for entries can be set. Time limits can be used to branch or provide students with helpful hints. In addition, students can be interrupted and put through remediation based upon their accumulated performance.

Students can be branched according to correct or incorrect responses. Since student performance is accumulated, they can also be branched according to their level of knowledge or decision making skills.

Course of Action imposes no limit on the number of anticipated responses. Since all responses are active, the system enables response-sensitive actions. This is a powerful option if properly used. Naturally language processing is limited to key words and for most applications, this was found to be adequate but in some situations restrictive.

Interactive video. Computer control of video is apparently simple. This aspect of the authoring system is currently being evaluated. Unfortunately, this option arrived too late to be properly evaluated.

Course Design. Branching options are very powerful with an unlimited number and pattern capabilities. Branching is achieved by linking icons. There are eight course design icons available: display, animation, erase, wait, decision, question, calculation and map. Graphic hierarchical presentations of the icons provide a clear outline of the course structure. This perhaps is the most powerful feature of the system.

The five cardiology units can be seen to be a course of significant size (i.e, 5000K). In a course of this magnitude the course structuring would normally have been a problem. The use a small number (i.e., eight) powerful design icons enabled even the neophyte programmer to easily and quickly create sophisticated CAI materials. Assembling courses in this manner was found to be particularly useful in building and testing highly nested course sections.

Once the course logic was established for one unit, the same basic logic was used to build the remaining four units. The separation of course logic from content saved enormous amount of time. This feature was seen to enable the development of outstanding interaction models which could be transported to other authors or courses. It clearly was seen how a library of models could be created and shared with other course developers.

External interface. Course of Action permits running of routines written in other languages (e.g., C and Pascal). Data can be passed to and from Course of Action to routines. External files can be created, written with data, and read as desired. Apparently, selected performance data can be transferred into a spreadsheet and used to compile performance data.

Student Performance Recordings. In addition, to data transfer capabilities, the authoring system provides extensive data collection capabilities through "system variables" and "system functions". These capabilities can retrieve any student answer, provide extensions to the text analysis capabilities, and plot data on screen. Thus, the system can easily provide a student with a score or other quantitative data for use in a variety of ways. However, it was extremely difficult to track the student results in the form of a permanent file for evaluation of student performance by the author. Since evaluation is an integral part of any CAI program, most authors require this information which should be an integrated part of the system's software. Unfortunately with the current method, the manual did not include examples of how to achieve this performance recording and many hours of labour were lost trying to figure the procedure that could be used. To date this difficulty remains unresolved and is a serious shortcoming of this author tool.

Screen Displays. On Macintosh System II microcomputers, the authoring system allows for a full color display. This feature was found to be an excellent method of color coding the lesson screens, which constantly reminded students which section of the program they were in. In addition, due to the complex nature of many of images, color was used to indicate specific growth regions in the heart, in lieu of arrows, resulting in uncluttered, pleasing pictures and diagrams. Although the color feature is useful, the system also works well on a monochrome screen.

Animation. The animation package that is included in the authoring system is well documented but limited to a maximum of 64 x 64 pixels. Due to the low resolution, one is limited to animating simple structures or moving objects such as arrows. Although these processes are easy to master they did not meet the need for animating complex anatomical structures. To a certain extent we overcame this limitation by aligning the individual cells of the subject to be animated on separate screens and running the entire screens in sequence, in a loop. One must note that this method uses a large amount of disc space and the speed of running the screens is limited by the speed of processor in the Macintosh being used. Optimally, it would be preferable to link a better animation application to the authoring system for those users who require better resolution and controlled movement of the images.

Sound Digitization. The sound digitization package supplied with the authoring system utilizes the application "Sound Wave". Besides a few "bells and whistles" which were used to make it interesting for the student, our primary use of the sound application was to digitize the heart sounds produced by the various heart defects. Although the sound application provides for a wide range of manipulation of the digitized sound, the quality of the sound is limited by the built-in Macintosh speaker. An external speaker was essential for complex heart sounds where students had to make fine cardiac discriminations. Perhaps in the future, the developers could supply an appropriate speaker as an option, along with the other digitizing hardware supplied.

Concurrency and Perpetual Options. The concurrency option allows a function to be performed with the one which follows. So, for example, a heart animation could be started along with the playing of a digitized sound. The two functions are performed together. This option was found to be extremely useful and necessary within the course.

The perpetual option allows the current function to be performed along with all of the following until the function is stopped or erased. For example, if the main menu was to be made available throughout the course, a push button labelled "main menu" could be perpetually active. This feature would be especially useful for a glossary of terms. This option was not used within the course.

Computer-Managed Instruction. Special capabilities permit Course of Action to jump to other non-Course of Action applications (e.g., Lotus 123). When the student quits using the software jumped to, Course of Action will resume exactly where it left off. This feature was not tested.

Portability. Currently, Course of Action has the ability to present courseware written on the Macintosh on both the Macintosh and IBM/IBM compatible microcomputers. This feature is supposedly automatic but was not tested at the time of writing this report. This feature will be tested in the near future.

Local Language. Course of Action is to be made available in a variety of languages (e.g., German and Chinese). Only the English version was tested.

Automatic Documentation. The system enables complete documentation of courseware design to be transcribed to paper. There are many printing options available. It automatically annotates the design by graphically printing the course flow. The individual icons can also be printed along with the content of each screen. This ability automatically prints a hierarchical schematic of the various course components, saved considerable time and improved the course presentation. An option of index cross-referencing each icon in the course, made it easy to work with the large course design. The print options were considered to be an invaluable aid.

Conclusion

"Course of Action" is the most comprehensive authoring system we have encountered to date. It allows a "content expert" with little computer background to design, input, and update a complex CAI program. Although this is possible, it is far better if resources permit, to work with a pedagogical expert and a programmer. A team approach permits the content expert is to spend more time designing the materials necessary to produce quality CAI experiences for students.

Although there are many fine features available in the authoring system, the three most positive features include ease of course design, creation and documentation. All the features of the system have been carefully designed and, in our opinion, would meet most CAI needs with medical education. However, a serious shortcoming is the lack of a switch to automatically turn on student performance recordings and we assume that Authorware would overcome this limitation in the near future.

Many of the difficulties and limitations that were encountered related to using a Fat Mac with lessons in excess of 5000K. This was seen to be a hardware limitation and not a system limitation. Even by generating the individual heart defect lessons as separate entities and amalgamating them for the final student version, we found that more than 1 meg of memory was required for most operations. In addition, utilizing the authoring system without a hard drive, even for writing or running the smallest of lessons proved impractical. One or two 800K floppy drive systems leave little room on the disk for the lesson. Thus, a Macintosh System II microcomputer is highly recommended.

In conclusion, we highly recommend Course of Action as an authoring system for those interested in developing large, complex CAI learning experiences. This system, in our opinion, is the best available to date.

Reference

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AN INTERACTIVE VIDEO TEACHING SURGICAL SKILLS

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Abstract

This paper will discuss the design and development of an InfoWindow module on Emergency Surgical Procedures including the design, instructional strategies, algorithms and authoring system used.

Introduction

This project was undertaken by the Office of Educational Services at the University of Colorado Health Sciences Center, and supported by the IBM Corporation. Content was provided by the Department of Emergency Medicine. InfoWindow was selected as the delivery system (hardware platform).

Design

The single screen interactive video format allowed a screen design which consisted of a video insert in the upper left corner occupying approximately 4/5ths of the screen. Surrounding the video insert is an overlay upon which user control/input options, text and feedback are displayed. This design allows consistent placement of user control/input options while simultaneously viewing the unobstructed video. User input and selection of control options are accepted via the touch screen.

Interactive video is a natural delivery medium for achieving objectives incorporating visual recognition skills such as the following.

- Given a tray of equipment used to perform thoracotomy, cricothyrotomy and related procedures, you will be able to identify the equipment by name.

Cognitive psychology suggests presentation of information and skills in a context similar to that in which the information and skills will be used. The instructional strategy selected for this objective is a mixture of drill and practice, discovery learning and gaming. User interaction begins with a video still frame of a surgical instrument tray is displayed in the video insert. The user is asked to select by touching an instrument when given its name. User options are "return to previous menu" and "help". Help allows the user to touch an instrument on the tray for more information using a hypertext/discovery learning approach. Displayed counters indicate the number of instruments correctly selected and the number of attempts to correctly select an instrument, incorporating a gaming strategy.

The algorithm for implementing this instructional strategy used a database and a looping structure. The database was constructed containing instrument names, touch area screen coordinates, and feedback, both positive and corrective. The looping structure, using a random number, control program execution and user interaction with information from the database.

Interactive video is also a natural medium when an objective incorporates components of psychomotor skills such as the following.

- Using computer software and a videodisc, you will be able to correctly perform a simulated cricothyrotomy, thoracotomy, perocardiotomy and thoracic aortic cross-clamping.

Again cognitive psychology suggests that practice is a critical component to the learning of a psychomotor skill. In establishing an instructional strategy, a task analysis of cricothyrotomy, thoracotomy and related surgical procedures was performed. The resulting procedural knowledge for each procedure created a database which was sequential, based on action, and contained information on the required instrument, material, orientation and extent for each action. From this database, an instructional strategy was designed using a practice format with positive and corrective feedback. The structure of the database arising from the task analysis suggested a menu system using overlaying windows. User interaction begins with a video still frame of the surgical field is displayed in the video insert. As the user selects an action, instrument, etc, the previous selection is maintained on the screen. The ability to change the previous selection is provided. After an action and all related items are selected, both text and video feedback are provided. Textual feedback is either positive or corrective. Video feedback contains a motion segment of the appropriate surgical action at this point in the procedure.

The algorithm for implementing this instructional strategy used a database and a sequential code structure. This structure called nested units generating overlaying windows from information in the database.

Development System

TenCORE was selected by the software designer/developer as the authoring system because of familiarity with the structure/syntax of the language, its flexibility, its ability to communicate with InfoWindow software and the use of both vector and bit-mapped graphics which yields compact executable code.

The surgical procedure practice section of the instructional module was extracted to create an assessment module. Data was collected during a field test using this module. Results from the field test will be presented if available.

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Selected Formal Papers from the

Special Interest Group for Home Economics Education (SIGHOMEC)

USING COMPUTER SPREADHSEETS FOR INSTRUCTION IN COST CONTROL CURRICULUM AT THE UNDERGRADUATE LEVEL

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This paper discusses how the instructional use of spreadsheets can help focus student attention on the influence of cost control variables and provide increased practice opportunities for students learning cost control concepts. Discussion addresses the question of whether any instructional improvements would justify increased use of computer spreadsheets for teaching content in undergraduate cost control courses.

NOTE: This work represents a small portion of a comprehensive study on the effects of computer spreadsheets on cost control concept attainment to be published in its entirety in the near future.

Introduction

The microcomputer has dramatically affected twentieth century education. Microcomputers offer educators unique opportunities for presenting curriculum and for addressing research questions about motivation, achievement, and long term consequences of this new technology (Lepper and Chabay 1985; Roblyer 1985).

The ability to use and understand computing is becoming as important as our ability to understand and handle the written word. A computer literate population is as necessary to an information society as raw materials and energy are to an industrial society (Deringer and Molnar 1982, p. 3).

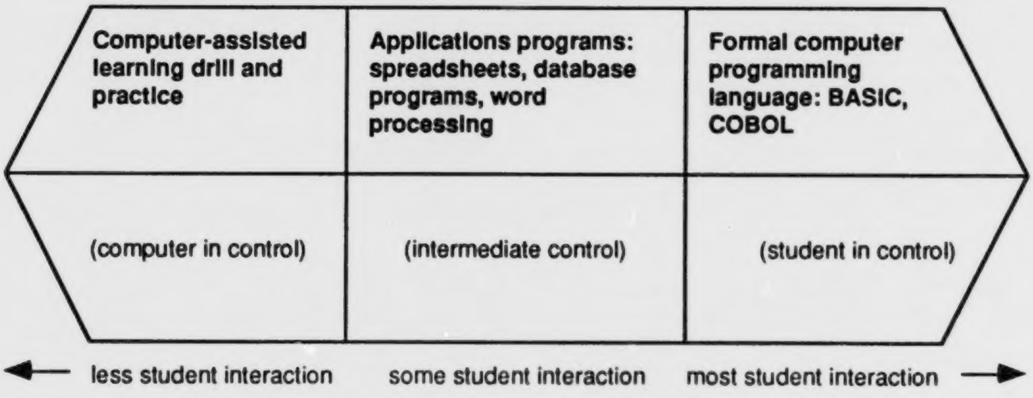
Not all educators would support the above quote in full; however, the basic premise is generally accepted throughout the educational community (Mynatt, Smith, Kamouri, and Tykodi, 1986). As microcomputers continue to pervade the classrooms of the country, the magnitude of impact is less clear. Therefore, education must address three questions: 1) What is the true impact of using computers in the classroom with respect to achievement, cost-effectiveness and unanticipated side-effects? 2) What curriculum content should be taught with computers? 3) How should this be accomplished?

Computers today represent a powerful tool for education. The computer of the year 2000 will be more powerful, changing the life of both teacher and student. "But it is not the tool that gets the job done, the person using it does," (Luke, et al, 1986, p. 8). Computer spreadsheets allow for the use of real-world problem sets and at the same time permit the student to work on concepts associated with the curriculum content as opposed to the mechanics of the problem. Furthermore, spreadsheets enable the user to capture and save the entire concept for future scrutiny and review; they provide the user with an array of feedback options.

Computer Software

Traditionally, most computer use in schools has been concentrated in two areas: pure programming skills such as BASIC or COBOL; and orientation/tutorial and practice programs commonly referred to as computer assisted learning or CAL (California State Department of Education 1985). Figure 1.01 suggests a continuum between CAL software programs and formal programming users as a function of control. Application software lies between the two traditional approaches offering the user structured interaction.

Figure 1.01. Computer Use and Student Control Continuum


Computer-assisted learning drill and practice
Applications programs: spreadsheets, database programs, word processing
Formal computer programming language: BASIC, COBOL
(computer in control)
(intermediate control)
(student in control)
less student interaction
some student interaction
most student interaction

Unlike CAL software, which commonly drills students on particular content matter such as vocabulary or mathematical computation (drill and practice), or presents information and suggest where the student should go next in the program (tutorial), spreadsheets provide an alternative dimension. Spreadsheets are tools designed to organize data, compute numeric variables and present solutions to real problems in a timely manner. The "tool" school of thought maintains that the computer is one of many tools devised by humans to help them perform certain tasks. What is critical is for the individual to use the computer to meet his or her need (Megarry, 1983).

Secondly, spreadsheets are used to illustrate financial models and other related applications through the use of data queries and sorts. This characteristic can be further exploited instructionally with the use of a special overhead projector, providing students the opportunity to see the effect of different numeric variables on model output. In essence, spreadsheets provide educators with a wide array of options to help promote learning financial concepts.

One of the single most important reasons for using application software for teaching is the amount of additional time a student may then have to spend on content-related problems. Ease of calculation provided by spreadsheets makes possible many practice opportunities related to numerical analysis. In addition, these application programs, such as spreadsheets, may also provide opportunities for the development of critical-thinking and problem-solving skills (Eastment, 1986).

Ironically, few students in the public schools use spreadsheets and data bases as learning tools in appropriate courses. Lambrecht (1986) found that business teachers in Minnesota avoid the computer for the teaching of content. Her findings reported an average of three topics out of a possible 19 were taught using the computer. Reasons for teachers not using application software for teaching related content in the classroom might be linked to the lack of available hardware. Furthermore, empirical research designed to address questions about computer spreadsheet effectiveness, appropriate curriculum content and methodology is very scarce.

More on Computer Spreadsheets

An illustration of computer technologies that can augment mental functioning is the electronic spreadsheet, such as Multiplan, Quattro and Lotus 1-2-3. Several million copies have been sold since they appeared in 1979 (Pea, 1985, p. 167). Electronic spreadsheets are software programs for micro-computers which serve as powerful tools. The screen images physically resemble paper ledger sheets, with cells organized in rows and columns. However, in an electronic spreadsheet, one can place a label, number, calculation, or a formula in any spreadsheet cell, which can subsequently be edited, copied, or moved. The results of calculations in the formula area appear as the content of the cell. The most dramatic difference from static paper spreadsheets is that one can change cell entries and see the repercussions of that change recalculated immediately throughout the spreadsheet (Levy, 1984). This what-if property has dramatic consequences for the development and use of budgeting and cost control models.

The typical spreadsheet also offers some limited programming language capabilities, including the ability to manipulate strings, write macros and to do interactive calculations. In addition, built-in functions can be combined to produce a plotting capability, thereby providing both a graphical and numerical method of illustrating relational concepts. Although the spreadsheet program requires that the user be able to specify the relationships to be explored, it does not require that the end-user be a programmer (Hewett, 1985).

Similarly, providing some students with spreadsheets as tools to experiment with cost control concepts vs. a lecture-discussion format without spreadsheets should result in different outcomes because of the unique activities associated with using spreadsheets.

Problem Statement

What is the effect on understanding cost control concepts when computer spreadsheets are used to: display cost control models, change key numeric variables within the cost control concept, provide multiple examples of concept use, allow active learner participation in model development and evaluation of spreadsheet feedback in contrast to using lecture/discussion methods to present and practice the same content?

Purpose of the Study

The purpose of this paper is to discuss the important issues surrounding the use of computer spreadsheets for the teaching of undergraduate cost control concepts. Methods for using the computer spreadsheet will be explained and supported with information processing theory.

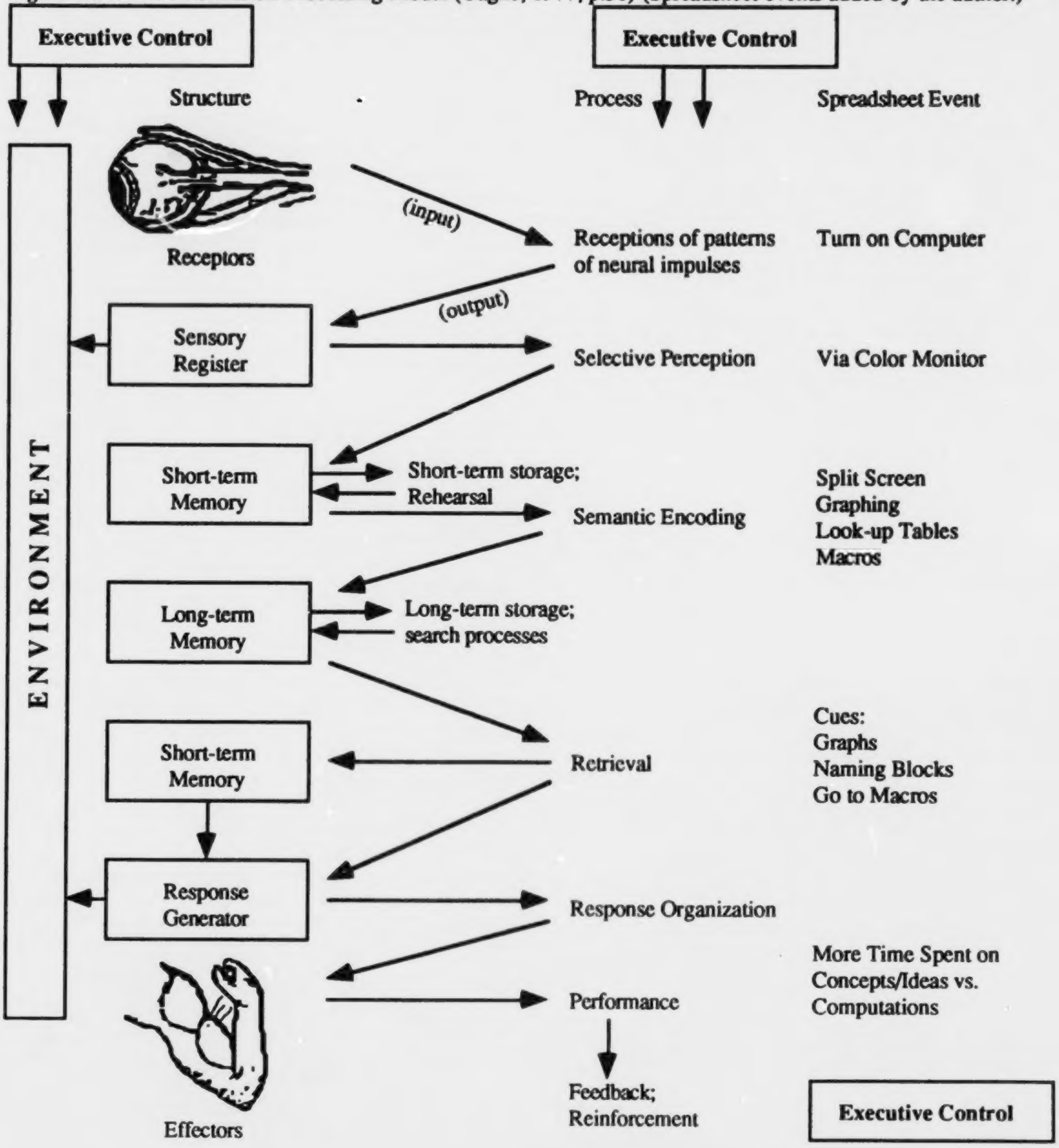
Need for the Study. Some of the more critical unanswered questions in education today deals with computers. Specifically, do computers significantly improve instructional methods and consequently student performance? Literature in the field contains numerous articles pertinent to computer assisted instruction (CAI) or computer assisted learning (CAL). However, there is no empirical research to support the use of application software (spreadsheets) for the teaching of content. Robert Gagné offers the following thoughts on the subject of computers and instruction.

> The computer remains a highly intriguing way of presenting instructional content, and of

> taking some account of the learner's response to content. Maybe learners simply prefer to look at screens rather than pages. Maybe they like the pressing of keys as a kind of concrete action that is not demanded by a page of printed text. Maybe the reassurance of a visual message displaying an answer to a question is inhevently more pleasing than looking up the answer on a printed page (1982, p 3).

The computer spreadsheet is a powerful tool, it provides the user with numerous opportunities to experiment with and evaluate information/data. If used appropriately, spreadsheetw can offer educators new variables in the area of instructional methodology. By granting students the use of spreadsheets to process, apply, and evaluate cost control concepts, it is possible to influence the events of learning (see Figure 2.01) as outlined by Gagné and Briggs (1974). Identifying which instructional event(s) the spreadsheet is influencing, and why, would be helpful for designers of instruction. If learners do prefer screens to written pages or pressing keys instead of using a pencil, educators need to know the degree of impact this has on learning performance.

Figure 2.01. The Information-Processing Model (Gagné, 1977, p.58) (Spreadsheet events added by the author.)


Executive Control
Executive Control
Structure
Process
Spreadsheet Event
ENVIRONMENT
Receptors
(input)
Receptions of patterns of neural impulses
Turn on Computer
(output)
Sensory Register
Selective Perception
Via Color Monitor
Short-term Memory
Short-term storage; Rehearsal
Semantic Encoding
Split Screen
Graphing
Look-up Tables
Macros
Long-term Memory
Long-term storage; search processes
Cues:
Graphs
Naming Blocks
Go to Macros
Short-term Memory
Retrieval
Response Generator
Response Organization
More Time Spent on Concepts/Ideas vs. Computations
Performance
Feedback; Reinforcement
Effectors
Executive Control

Understanding the specific outcomes of application software on student performance in relation to the events of instructions will help educators address issues surrounding: 1) the role education should play in preparing students to use application software as tools in appropriate curriculum; 2) the best way to integrate application software with content; and 3) the impact of application software feedback on student performance on concept attainment.

Assumptions

The following assumptions are made:

1. The external events and dynamics of a learning situation influence learning. These include: availability of stimulation to activate attention, variety and type of cues available for student perception, suggested schemes for coding information, suggested schemes for remembering/retrieval, opportunities to transfer learning to a new situation, actual student performance and reinforcement/feedback.
2. The use of computer spreadsheets as tools provide unique external events with respect to how information is processed. This is attributed to the spreadsheets' capability to stimulate student attention; promote schemes for coding and retrieval/storage of information; permit the student to develop, apply and manipulate a concept in its entirety--saving the work for easy retrieval and review; allow the user to change numeric variables--resulting in unlimited what-if testing; and provide the student with timely evaluation of spreadsheet feedback.

Nature of Instruction

To reach the objectives of this study two instructors taught one experimental group and one control group each. The population of each was set at 41, for a total of 82 subjects.

For the experiment, all classes met in the same building utilizing a traditional classroom for the control groups, and the computer laboratory for the treatment groups. This facility is equipped with 21 IBM PS-2/Model 30 computers utilizing a local area network (LAN). This system uses the PS-2/Model 60 as a file server, with each individual PS-2/Model 30 workstation having the ability to access programs loaded on the file server. The Quattro spreadsheet was used for the experiment.

The experimental groups (spreadsheets) were introduced to the Quattro spreadsheet through a six lesson tutorial program, published by the software company (Getting Started with Quattro, 1987). Two weeks of instructional time was allocated to orientation and instruction on how to use the spreadsheet.

Instruction in both the experimental and control groups was accomplished by the instructor introducing cost control concepts via the computer. A special overhead projector (SHARP QA-50 Computer Projection Panel) was used to display information from the instructor's computer monitor onto a large wall screen, allowing the entire class to see a functional spreadsheet perform. In addition, each student was provided with a hard copy of the spreadsheet model to serve as resource and provide step-by-step instructions on how to complete the concept assignment.

All subjects were introduced to the concepts by the instructor demonstrating each one of the cost control models on the computer and a QA-50 (special overhead) projector. In addition, the student was provided hard copies of the concept lesson and a cost control textbook.

In the experimental group, the students were provided with computers to allow for the building of their own model worksheet using the spreadsheet at their work station, or calling up a partially completed worksheet and completing the model by entering the necessary formulas and formats to make the spreadsheet operative. Subjects could compare their own spreadsheet model to the instructors by utilizing the computer file server. The student had regulated access to a collection of cost control concepts on the file server.

Control groups were instructed through an identical method. The instructor demonstrated the cost control concept using the computer spreadsheet and presented this material via the QA-50. However, the control group did not have use of a personal computer at their workstation to serve as a resource for work and practice on cost control concepts.

The researcher believes the external conditions which contribute to learning in a traditional lecture-discussion approach will be considerably different from the eltemal conditions present when computer spreadsheets are available for each student to serve as a tool.

A close examination of two environments (one with spreadsheets--one without) identify how and why the environments are different as well as alike. Specific learning phases include: the stimulus; feedback; and opportunity for practice. The spreadsheet offers users external conditions which encourage additional experimentation and can possibly draw out a greater response from students with spreadsheet availability vs. those without, Table 1.01 compares and contrasts the role spreadsheets play in the learning phases and relates it to the instructional events as outlined by (Gagné , 1977).

Summary

The instructional use of spreadsheets can improve educational outcomes in undergraduate cost control curriculum through:

1. *The Tool Metaphor*. Provide the learner with a powerful tool that will allow for increased practice opportunities, serve as a contemporary

tool to apply cost control concepts and offer "what-if" testing scenarios.

2. *The Medium and Method.* Serve as an efficient vehicle to transport educational concepts from teacher to students via special technology allowing for the demonstration of cost control concepts using real data. The computer spreadsheet medium will allow the instructor to use a variety of methods to present material to students—increasing the chances of identifying the optimum method.
3. Teaching Valuable Technical Skills. Expose the student to the technical skills associated with personal computers and application software, teaching them how to use computer technology in the work environment they plan to pursue as a career.

Table 1.01. Instructional Events and Associated Learning Phases

THE INSTRUCTIONAL EVENTS	LEARNING PHASES ASSOCIATED WITH EXPERIMENT
Example of how a concept was presented for learning in the experimental group (spreadsheets) and the control group (no spreadsheets).	
All students participating in the study received a copy of the major concept to be discussed. This resource included the following information and characteristics: a) The cost control concept was provided in written form. This model concept was produced by a computer spreadsheet and did depict actual data under two different sets of conditions to help the student see a comparison and contrast of the key variables, and how this influences the end results. b) The model concept did include the following attributes: description of the cost control concept, how the concept is used in the cost control area, and pertinent formulas associated with the concept. c) The model concept also included references to rows and columns as found on a working spreadsheet.	1. *Activating motivation:* The individual strives to achieve the goal of learning cost control concepts, and in the experimental group the use of a computer spreadsheet. *Differences between treatments:* The expectancy of learning computer spreadsheets in the experimental group coupled with heightened motivation. *Implication:* Heightened motivation resulting from the novelty associated with computers and individual student expectancy during early stages of the experiment, however, this expectancy is likely to decrease over the 16 week study and is unlikely to have a significant effect on cost control concept attainment over the long run.
Students in both groups were introduced to the *model concept* by the instructor using a lecture-discussion approach.	2. *Informing learner of the objective:* Communicating to the learner the desired behavior or performance they will be capable of as a result of the lesson. *Differences between treatments:* None
Students in the experimental group and control group did witness a demonstration of the cost control concept on the instructor's computer spreadsheet; the screen image was displayed via a special projector on a large wall screen. All students witnessed how the model works. Actual data was manipulated using a "what-if" orientation. Lecture-discussion focusing on the cost control concept will follow.	3. *Directing attention:* This event in the lesson is directing attention to the stimuli which are an inherent part of the learning task. In this study both control group and experimental group will witness the same demonstration. *Difference between treatments:* None 4. *Stimulating recall:* This event is designed to help the learner access previously learned capabilities. *Differences between treatments:* None
Students in the control group spent time developing a model of the same cost control concept, however, this group utilized the chalk board instead of the computer spreadsheet to build the model. Students in the control group did have access to lecture notes, textbook, and other class handouts to serve as resources--as well as a source of feedback.	5. *Providing learning guidance:* These events form a part of instruction during this learning phase. The amount of learning guidance provided (the length and complexity of the communication or other form of stimulation) will vary depending on the content and type of students involved in the learning process.

Table 1.01. Instructional Events and Associated Learning Phases (cont'd)

THE INSTRUCTIONAL EVENTS	LEARNING PHASES ASSOCIATED WITH EXPERIMENT
Students in the control group spent time developing a model of the same cost control concept, however, this group utilized the chalk board instead of the computer spreadsheet to build the model. Students in the control group did have access to lecture notes, textbook, and other class handouts to serve as resources--as well as a source of feedback.	The most common characteristic to be sought in learning guidance is the orientation to the objective. In whatever form it is given, whether as verbal statement, hints, diagrams, pictures, or spreadsheets the purpose is to insure a form of encoding which will enable the learner to recover what he had learned and display it as some kind of performance at a later time. Considering the outcome of cost control concept attainment, (the ability to apply the concept to a realistic situation) the spreadsheet provides the student with a unique opportunity to actually build the idea on a electronic tablet, demonstrate the finished product, receive feed back on some numeric formulas and develop a variety of personalized cues for future reference. This difference suggests a definite advantage regarding learning and overall performance for the experimental group.
A cost control concept problem was distributed to both experimental group and control group. Students were required to answer questions regarding the cost control concept.	6. *Enhancing retention:* Instructional provisions for enhancing retention and receipt of feedback take the form of spaced reviews. This step will preface the distribution of a review problem distributed to both groups. *Difference between treatments: None* 7. *Promoting transfer of learning:* Promotion of transfer is brought about by instruction which provides novel tasks for the student, spaced over time, and calling for the use of what has previously been learned. This phase often takes the form of solving a problem or designing an investigation for a given problem. *Difference between treatments:* The experimental group will have the use of the spreadsheet tool to assist in getting at the answer, building the control model, or predicting a outcome. Using the notion that the spreadsheet tool is a "amplifier of cognition," the user will have the advantage of being able to perform more problems in less time. *Implication:* The experimental group will benefit because of the increased exposure to practice problems afforded by the spreadsheet. The spreadsheet is likely to improve the transfer phase of learning because of increased activity.
Both groups participated in a review and discussion activity focusing on the cost control concept. Feedback was provided in the form of correct answers (attached to the original model) and a presentation of the model using the instructors computer and special screen projector for all students to see. In addition, students in the experimental group had access to a completed model accessible from computer file server. Group discussion explained the outcomes and identified the correct response(s). Each student was able to compare their work to the correct copy displayed on the screen or printed on the handout.	8. *Eliciting the performance; providing feedback*: It is important to provide an occasion for the display of the performance by the student. Having learned, the student needs to "show what he can do," not only for the teacher's purpose, but for his own learning. This is referred to as informative feedback.

Table 1.01. Instructional Events and Associated Learning Phases (cont'd)

THE INSTRUCTIONAL EVENTS	LEARNING PHASES ASSOCIATED WITH EXPERIMENT
Both groups were administered a concept quiz after the review and discussion period was completed. The concept quiz measured how well the subject understood the concept (number correct) and the amount of time (in minutes) it took to complete the quiz. The experimental group used the computer spreadsheet to work through the concept, while the control group relied on the hand calculator.	*Implication:* Students in the experimental group are likely to check their work against their spreadsheet model for accuracy and correctness more often then the control group students. This is explained by the limited capabilities of static paper copy information (control group) vs. a dynamic spreadsheet model--capable of recalculations, and in some instances--alerting the user to errors in logic and formulas.

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COMPARISON OF TRAINING RECEIVED AND DIFFICULTIES ENCOUNTERED DURING COMPUTER CONFERENCING BY UNDERGRADUATES IN CONSUMER ECONOMICS

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Abstract

A training model is proposed for assisting new users of computer conferencing to utilize effective communication strategies while debating electronically by means of an network. Five parameters suggested include computing prerequisites, technical skill development, communication strategy expansion, human sensitivity training, and study/research skill utilization.

Computer conferencing *reflects a process* which may require individuals to adapt previously acquired communication skills in order to utilize electronic communication effectively. The preparation of individuals to assume active roles within an integrated, computer-based network appears to be a consideration of growing importance if organizational administrators are to take advantage of the potential of new emerging technology. The intent of this research was to *develop an experiential training model for preparing individuals to utilize computer conferencing effectively.*

Study Sample

The participants in the research experiment consisted of 24 undergraduates, majoring in the field of economics, at the University of Delaware in Newark. The specific course in which these individuals registered was labeled, Consumer Laws and Regulations, which merited 3 undergraduate credits upon its completion. The sample consisted of 5 males and 19 females. Each student had completed an introductory course in business computing applications by the end of the Sophomore year. The sample included 13 juniors and 11 seniors. Only one individual in the sample indicated prior experience participating in a computing network at the initiation of this experiment. No one in the sample had any prior experience utilizing computer conn a problem-solving capacity.

Research Design

The data collected resulted from an experiment which was conducted over a four-week period between November 17, 1989, and December 15, 1989. In addition, a one-week training period preceded the actual experiment.

Software and Hardware. The research experiment conducted at the University of Delaware used the CONVENE conferencing software as the mechanism for networking the 22 students into a problem-solving project. An IBM 3090 mainframe at the University was the host machine to which the students used personal-business computers from a variety of locations on campus. The personal-business computers were computing terminals which were hard-wired to the mainframe. thus not requiring the need for any floppy disks by the student. Zenith and IBM computing terminals were utilized by the students when keyboarding contributions and re-plies during the conferencing project. The CONVENE conferencing software is an application's program which permits individuals to communicate with one another in a group format. The software package makes use the BITNET as the mechanism for enabling individuals to communicate asynchronously by means of electronic keyboards attached to computing terminals.

Research Methodology. The experiment was carried out in two phases: (1) a training model implemented over a one-week period; and (2) a four-week computer conferencing experiment.

During the initial one-hour training session, the process of logging on and off the IBM mainframe was reviewed in addition to the editing process for making corrections as messages are keyboarded. During the second one-hour session, the undergraduates were introduced to CONVENE and guided in its use as a conferencing tool. The third one-hour session permitted the under-graduates to practice using CONVENE and to actually begin keyboarding their messages to one another as the problem-solving project began.

The problem to be solved by the students was presented to them by means of CONVENE conferencing software. The undergraduates were guided to access three messages which provided the parameters for their study. The students were requested to take one of four positions related to the marketplace issue of product liability. defend their positions among one another, and then submit a final statement to their instructor using no more than 1000 words. During the initial two weeks of the experiment. the undergraduates were required to identify at east five weaknesses in their position by interacting with other classmates--and submit this list to their instructor. During the final two weeks. each participant was requested to develop a credible defense for their position on product liability by seeking comments, etc., that assisted them in responding to each of the five weaknesses previously identified--and keyboard that statement(defense) to their instructor by electronic mail at the conclusion of the experiment.

All students were assigned secret code labels that were not to be shared with each other. These labels consisted of names of various countries throughout the world. Therefore. students did not know the identity of those individuals with whom they were communicating. All conferencing was conducted outside of normal class routines--and no discussions related to computer conferencing and the problem-solving project occurred between faculty and students within a classroom setting during the experiment.

Two sets of questionnaires were utilized for gathering data from the study sample. Each set of questionnaires adopted a 5 point Likert-type scale in which participants were requested to indicate their perceptions of both the training program and experiences encountered during computer conferencing project.

Version 5 of the computer-based SAS System (an acronym for Statistical Analysis System) was utilized for analyzing data collected. A T-Test (an analysis of variance measure) was per the data gathered related to confidence levels of participants at the conclusion of training received and the degree of difficulty of problems encountered during computer conferencing. These statistical procedures were performed using the IBM 3090 mainframe at the University of Delaware.

Findings

Data analyzed consisted of responses recorded on two sets of questionnaires by participants reflecting their perceptions related to 12 competencies which were introduced and practiced during a one-week training program and then utilized during the four-week experiment on computer conferencing. The purpose of this analysis was to determine if there were any significant differences between the perceptions of individuals as related to the degree of training received and actual post-training technical problems encountered.

n comparing the mean scores of perceptions recorded by study participants for each of 12 competencies at the end of the one-week training session and at the conclusion of the experiment (as indicated in Table 1 on next page) it appeared that there was a difference in the perceptions of participants as related to training program accomplishments and actual difficulties with the technical aspects of computer conferencing. There were only 4 competencies during the training program which participants indicated a rather high confidence level for performing: that is, having a mean rating of 3.75 or higher on a 5-point rating scale. These four included logging on (4.54). logging off (4.45). using the PF legend function keys (4.14). and contributes (3.91). However, there were eight competencies in which participants had very little difficulty performing at the computer keyboard: that is. difficulty mean ratings of 3.75 or above on a five-point rating scale, indicating only a very slight problem. These 8 competencies included logging on (4.91) logging off (4.82) using PF legend function keys (4.45) contributing comments (4.19) reviewing old comments (4.19) searching for new comments (4.05) using special CONVENE keys (3.95). and accessing conference (4.05).

Table 1. Mean Scores of Confidence Levels of Participants at the Conclusion of Training Compared to Degree of Difficulty as Related to Technical Problems Encountered During Computer Conferencing (N = 22).

Competency	**Training Confidence Level (1)**	**Conferencing Technical Problems (2)**
Logging off ACSVM	4.54	4.91
Logging on ACSVM	4.45	4.82
Using PF Legend Functions	4.14	4.45
Contributing Comments	3.91	4.19
Using Electronic Mail	3.73	3.73
Reviewing Old Comments	3.55	4.19
Searching New Comments	3.36	4.05
Using Special CONVENE Keys	3.32	3.95
Accessing Conference	3.23	4.05
Getting Help/Solve Problems	2.96	3.55
Editing Comments	2.90	3.36
Printing Comments	2.64	3.50

Note: Rating scale for difficulties encountered in Column 2 was recoded from original tallies to permit analysis of matching perceptions. A rating of 5 indicates great confidence for data appearing in Column (1) and no difficulty encountered in data in Column (2) above.

Therefore, it appeared that the degree of confidence at the end of the training program did not match the degree of difficulty in the kinds of technical problems being encountered during the computer conferencing experiment. In each instance except for the one competency of using electronic mail, the level of difficulty encountered was considerably less in degree than that associated with the confidence level at the conclusion of the training program.

The differences in perceptions between the training model experience and the difficulties encountered during the computer conferencing experiment appeared to be significant. Using a Paired T-Test statistical measure, Table 2 on the next page re for 10 of the 12 competencies, the mean scores of the differences of perceptions were not equal. Therefore. there appeared to be a significant difference between the degree of confidence levels held at the conclusion of the training program and the degree of difficulty encountered when performing those same competencies during computer conferencing.

Table 2. Paired-Comparison T-Test of Mean Scores of Differences Between Confidence Levels at the Conclusion of Training and Difficulty Levels During Computer Conferencing (N = 22)

Competency	Mean	Std. Error of Mean	T
Logging on ACSVM	0.364	0.124	2.94[a]
Logging off ACSVM	0.364	0.124	2.94[a]
Accessing Conf.	0.818	0.252	3.25[a]
Rev. Old Comments	0.636	0.168	3.78[a]
Search. New Comments	0.682	0.202	3.38[a]
Printing Comments	0.864	0.274[a]	3.16[a]
Contributing Comments	-0.682	0.266	-2.56[b]
Using PF Legend Functions	0.318	0.212	1.50[b]
Using Special CONVENE Keys	0.636	0.203	3.13[a]
Editing Comments	0.455	0.215	2.11[b]
Using Elect. Mail	0.000	0.208	0.00
Getting Help/ Solve Problems	0.591	0.269	2.20[b]

[a] Significant at the .01 Level.

[b] Significant at the .05 Level.

For 8 of the 10 competencies listed in Table 2 (except for editing comments and getting help to solve problems) these findings were significant at the .01 level.

Conclusions:
Parameters of Proposed Model

In establishing a training model for assisting new users of computer conferencing to utilize effective communication strategies, five parameters were identified: computing prerequisites; technical skill development: communication strategy expansion: human sensitivity training: and study/research skill utilization. A two-phase training model is proposed to permit new users to not only become acquainted with computer conferencing but to receive sufficient practice before entering into the formal problem-solving process. The resulting proposed three-week training model includes a one-week introductory session followed by a two-week guided practice session in which a trial exercise is completed enabling users to practice questioning skills. It was also concluded that trainers must be careful not to assume that new users of computer conferencing will automatically transfer prior problem-solving skills practice in non-computer surroundings to computer environments.

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HOME ECONOMICS TEACHER EDUCATORS PERCEPTIONS OF COMPUTER COMPETENCE AS COMPARED TO OTHER VOCATIONAL TEACHER EDUCATORS

Cecelia Thompson, Dale E. Thompson, and Lori M. Shimomura

Abstract

The purpose of this study was to compare home economics teacher educators self-rated level of computer competence to those of agriculture, industrial, and business teacher educators. The study also determined vocational students' use of computers and suggestions of what was needed to improve computer competence.

A random sample of 191 home economics, agriculture, industrial, and business teacher educators was selected from professional directories for participation in the study. One teacher educator in each vocational area was selected from all states with vocational programs.

A questionnaire developed by the researchers was used to gather data. The questionnaire items examined the areas of use of computer hardware and software, level of competence, what is needed to improve personal computer competence, use of computers by vocational students, and what is needed to improve student's competence. The demographic variables included age, years of experience, gender, computer training, and type of computer used. A total of 109 questionnaires were returned from 20 home economics educators, 26 industrial educators, 39 agriculture educators, and 24 business educators.

All vocational groups showed similar levels of computer competence and use. Most ranked themselves fair to good on levels of computer competence. Most used the computer and printer for word processing. Almost all vocational educators were self-taught and perceived time for self-study as most needed to improve their level of competence. Almost half felt competent to teach about the computer and to teach using the computer.

Home economics educators indicated a lower level of computer competence than other vocational educators. They also indicated a lower level of competence to teach about and teach using computers.

Respondents in the total group indicated that vocational students frequently used the computer for word processing. Students used the computer less often for database, spreadsheets, and tutorials. Students rarely use the computer for programming and CAD. The respondents indicated that class assignments and projects would increase computer competence.

Respondents self-rated level of computer competence is low if vocational educators should be on the cutting edge of technology. This level of competence may be the result of self-study as the primary method of computer training. Most respondents indicated that time for self-study would provide the most help in improving their level of competence. Few recognized the value of formal university courses or technical workshops as a method to learn the intricacies of working with computer hardware and software.

The respondents make use of word processing for day to day writing tasks. However, they do not take advantage of other technology appropriate for use in their areas.

Respondents indicated that students frequently use the computer for word processing and other tasks. The respondents also indicated that class assignments and projects using the computer would improve student's level of computer competence. However, it is possible that the level of competence held by the teacher educators would not allow them to plan, assign, and teach about projects suitable for expanding students' computer competence. Home economics educators also indicated a need for more computer hardware and software to improve students' competence.

Introduction

Computers are an important part of education in today's high tech world. The first national assessment of computer competency revealed that 87 percent of students have used a computer by the eleventh grade (Martinez and Mead, 1988). Tweeten (1988) stated that students entering school today already possess a degree of computer literacy. Often, they are more knowledgeable about computers than their teachers. Students' progress toward computer literacy can be hindered by their teacher's lack of knowledge.

Although most schools acquired computers, many teachers found themselves inadequately prepared to teach about computers. Most graduated from college before many computer courses were offered. Many teachers do not feel confident about their computer knowledge and skills(Martinez and Mead, 1988)

It is an obligation of teacher educators to introduce computer technology to both new and experienced teachers"The ultimate success of the microcomputer in education depends on it becoming an everyday classroom tool, much as chalk and pencils are, rather than being an object of special attention." (Lockard, Abrams, and Many, 1987, p. vii) To accept the computer as an everyday tool, teachers must be comfortable using it for personal and educational tasks, and they must be committed to making effective use of computers. (Lockard, Abrams, and Many, 1987)

Teacher educators must assess their own skills and attitudes about computers because they are responsible for teaching computer competencies. If teacher educators lack the skills necessary to teach about computer use, they must seek to change their attitudes and level of competency.

Educational change and the implementation of new or different systems are difficult at best. The situation is made even more difficult when a new or unfamiliar technology is involved. The change will be somewhat threatening to a few individuals. Therefore, an understanding of the change process and methods for planning and implementing change is most important. This insight, coupled with sufficient knowledge of computer-based education, can bring about the 'critical mass' necessary for success. (Bozeman, 1985, p. 192)

Purpose of the Study

The purpose of this study was to compare home economics teacher educators self-rated level of computer competence to those of agriculture, industrial, and business teacher educators. The study also determined vocational students' use of computers and suggestions of what was needed to improve computer competence.

Methods

A random sample of 191 home economics, agriculture, industrial, and business teacher educators was selected from professional directories for participation in the study. One teacher educator in each vocational area was selected from all states with vocational programs.

A questionnaire developed by the researchers was used to gather data. The questionnaire items examined the areas of use of computer hardware and software, level of competence, what is needed to improve personal computer competence, use of computers by vocational students, and what is needed to improve student's competence. The demographic variables included age, years of experience, gender, computer training, and type of computer used.

A total of 109 questionnaires were returned from 20 home economics educators, 26 industrial educators, 39 agriculture educators, and 24 business educators.

The majority (55.56%) of home economics educators responding to the questionnaire were 41-50 years of age while 35.51% of the total group were 41-50 years of age and 32.7% were 51-60 years of age. Approximately one-thirds of the home economics respondents reported 0-10 years experience (33.33%), 11-20 years experience (27.78%), and 21-30 years experience (33.22%). In the total group, 25.23% reported 0-10 years experience, 36.45% reported 11-20 years experience, and 26.17% reported 21-30 years experience. Most (88.89%) of the home economics educators were female while 77.57% of the overall group was male.

Most respondents in all groups reported that they received their computer training from self-study. Some reported taking university courses or inservice workshops.

Table 1. Computer Training

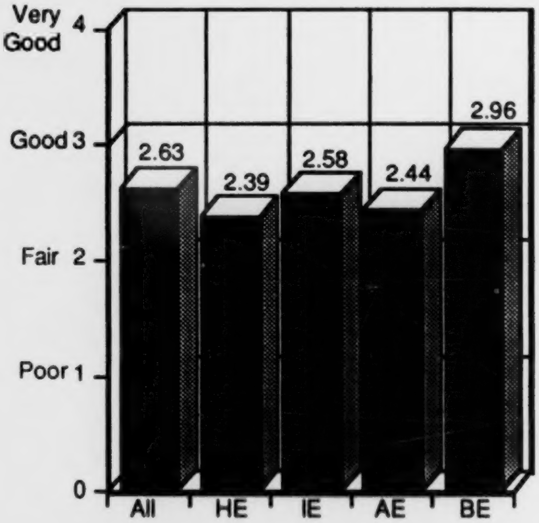
	Self-Taught	Univ. Course	Inservice	Dealer Course
All	72.90%	9.35%	11.21%	1.87%
HE	44.44%	33.33%	5.56%	0.00%
IE	80.77%	3.85%	7.69%	0.00%
AE	74.36%	5.13%	15.38%	5.13%
BE	83.33%	4.17%	12.50%	0.00%

Most vocational educators used an IBM computer (65.42%) followed by Macintosh (20.56%) and Apple II/GS (9.35%). Sixty-one percent of home economics respondents used IBM followed by 16.67% using a Macintosh, and 11.11% using an Apple II/GS computer.

Findings

When asked to rate their level of competence of computer use, the overall group reported a mean of 2.63 which indicated a level between good (3) and fair (2).

Figure 1. Computer Competence of Vocational Educators



Home economics educators rated their mean level of competence at 2.39, Industrial educators rated a mean level of competence of 2.58, agriculture educators rated a mean level of competence of 2.44, and business educators rated a mean level of competence of 2.96. All individual groups rated their level of competence between good and fair.

Most respondents in the total group reported using the computer (67.29%) and printer (65.42%) almost everyday, while never using a modem (54.21%) or scanner (73.83%). Sixty-one percent of the respondents in the home economics group reported using a computer almost everyday and 55.56% reported using a printer almost everyday. In the home economics group, 72.22% never used a modem and 88.89% never used a scanner.

Word processing was used by 67.29% of all respondents daily while 55.56% of home economics educators used word processing daily. Other computer applications used by specific vocational groups reflected the needs of their areas.

Approximately 22% of home economics respondents used databases daily or weekly while 38.89% used them once a month and 38.89% never used them. Only 11.11% of the home economics respondents used spreadsheets once a week, 38.89% used spreadsheets once a month, and 50% never used spreadsheets. Most respondents (88.89%) never used CAD (Computer Aided Design).

Industrial education respondents reported that 61.54% never used a database and 53.85% never used spreadsheets. Daily use of CAD was reported by 23.08% of the respondents, weekly use was reported by 7.69% of the respondents, monthly use was reported by 19.23%, and 50% reported never using CAD.

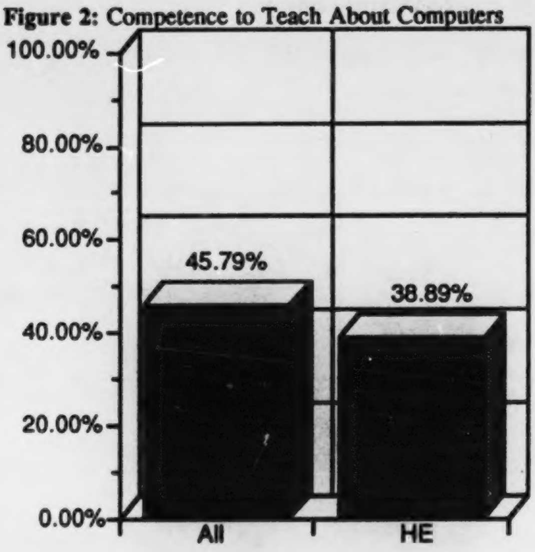
Agriculture respondents reported that 35.9% used database applications daily or weekly and 51.28% used spreadsheets daily or weekly. Approximately 95% reported that CAD was never used.

Business respondents reported that 68.18% use database application daily or weekly and 66.67% use spreadsheet applications daily or weekly. Approximately 79% of the business respondents reported that they never used CAD.

When asked to identify what would be most helpful in improving their level of competence, 49.53% of the respondents indicated time for self-study, 31.78% indicated technical workshops, 13.08% indicated availability of funds for hardware and software and 0.93% indicated university courses. Approximately 61% of the home economics respondents indicated time for self-study as most helpful in improving level of competence.

Most (75.7%) reported that they did not teach computer courses. However, approximately half of the respondents felt adequately prepared to teach about computers (45.79%) and teach using computers (52.34%). The percentage was lower for home economics educators. (Figures 2 and 3)

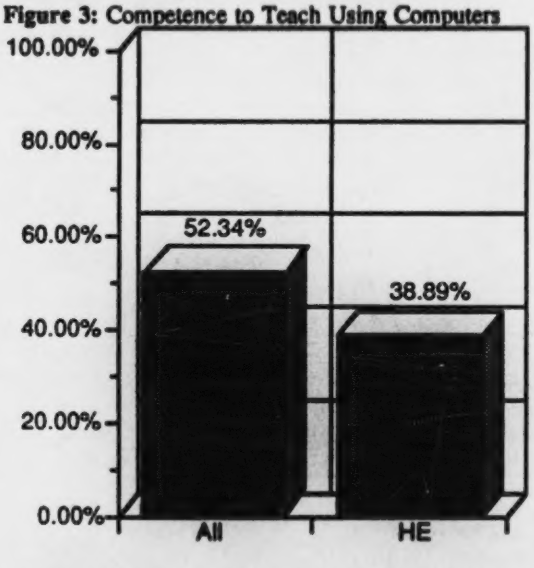
Figure 2: Competence to Teach About Computers



When asked to indicate competence to teach computer applications, the percentage of home economics educators responding yes was lower than the total group in all areas (Figure 4).

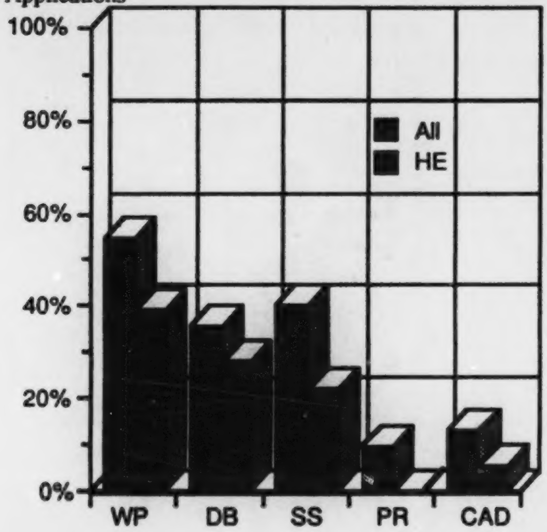
Respondents were also asked to indicated student use of computers. Almost 85% of the respondents indicated that students in their area used a computer daily or once a week for word processing. Other applications were used less frequently by all groups (Table 2).

Figure 3: Competence to Teach Using Computers



Almost half of all respondents (50.47%) and 33.33% of home economics respondents indicated that projects and class assignments would be most helpful in improving students' level of computer competence. Most home economics educators (44.44%) ranked availability of hardware and software as most helpful.

Figure 4. Competence to Teach About Computer Applications



Summary

All vocational groups showed similar levels of computer competence and use. Most ranked themselves fair to good on levels of computer competence. Most used the computer and printer for word processing. Almost all vocational educators were self-taught and perceived time for self-study as most needed to improve their level of competence. Almost half felt competent to teach about the computer and to teach using the computer.

Home economics educators indicated a lower level of computer competence than other vocational educators. They also indicated a lower level of competence to teach about and teach using computers.

Respondents in the total group indicated that vocational students frequently used the computer for word processing. Students used the computer less often for database, spreadsheets, and tutorials. Students rarely use the computer for programming and CAD. The respondents indicated that class assignments and projects would increase computer competence.

Conclusion

Respondents self-rated level of computer competence is low if vocational educators should be on the cutting edge of technology. This level of competence may be the result of self-study as the primary method of computer training. Most respondents indicated that time for self-study would provide the most help in improving their level of competence. Few recognized the value of formal university courses or technical workshops as a method to learn the intricacies of working with computer hardware and software.

The respondents make use of word processing for day to day writing tasks. However, they do not take advantage of other technology appropriate for use in their areas.

Respondents indicated that students frequently use the computer for word processing and other tasks. The respondents also indicated that class assignments and projects using the computer would improve student's level of computer competence. However, it is possible that the level of competence held by the teacher educators would not allow them to plan, assign, and teach about projects suitable for expanding students' computer competence. Home economics educators also indicated a need for more computer hardware and software to improve students' competence.

Table 2. Students' Use of Computers

	Almost Everyday		Once a Week		Once a Month		Never	
	All	HE	All	HE	All	HE	All	HE
Word Process	47.66%	44.44%	37.38%	33.33%	6.54%	11.11%	3.74%	5.56%
Database	10.28%	5.56%	27.10%	22.22%	27.10%	22.22%	28.04%	44.44%
Spreadsheets	10.28%	0.00%	29.91%	16.67%	27.10%	22.22%	27.10%	55.56%
Programming	3.74%	0.00%	4.67%	5.56%	24.30%	22.22%	57.94%	66.67%
Tutorials	6.54%	0.00%	28.97%	27.78%	33.64%	27.78%	22.43%	38.89%
CAD	9.35%	0.00%	9.35%	5.56%	8.41%	5.56%	62.62%	83.33%
Statistics	5.61%	5.56%	23.86%	16.67%	31.78%	33.33%	31.78%	38.89%
Testing	4.67%	5.56%	18.69%	22.22%	34.58%	22.22%	33.64%	44.44%

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Selected Formal Papers from the

Special Interest Group for HyperMedia Education (SIGHYPER)

PROGRAMMING TECHNIQUES FOR INTERACTIVE CONCEPT DEVELOPMENT IN HYPERCARD

James Baggott, Hahnemann University School of Medicine; and Sharon E. Dennis, Medical College of Pennsylvania

Abstract

Successful CAI for medical students needs to be information-dense, yet clear and visually appealing. The *show* and *hide* commands of HyperCard can be applied in a user-controlled manner to reversibly build complicated narrative, tabular or graphic material. Techniques for each have been developed and are described.

Introduction

Interactivity and user control are among the most valued principles of modern computer assisted instruction (CAI) design. Indeed, the attractiveness of hypermedia programs derives not only from the rich sensory experience of color graphics, animation, sound, *etc.*, but from the potential for users to explore information in the way they wish, when they wish and as often or as little as they wish. CAI for pre-clinical medical students must, however, acknowledge the unusual constraints placed upon this category of adult learners by the crowded, lock-step medical school curriculum. These students are expected to master more information in less time than probably any others. As a result, they are inclined toward learning techniques that they perceive as most likely to produce satisfactory performance in minimal time (Newble and Entwistle, 1986)

The medical school environment thus challenges the CAI developer to facilitate learning large amounts of material efficiently and in a manner that will be interesting. As partial compensation, medical school offers a select group of learners, highly motivated individuals with above-average powers of concentration and ability to think abstractly.

A dilemma imposed upon the medical CAI designer is that each display of information should be dense enough to be meaningful, yet it must avoid a cluttered appearance that would generate confusion. Information-dense screen displays can assist integration of knowledge by bringing out relationships among elements of information *via* a comprehensive visual impression. Further, highly motivated learners sometimes lose patience with programs whose intellectual reward for the effort of going from screen to screen is too small.

Methods

In writing Medical Biochemistry CAI intended to replace completely the corresponding traditional lectures, we have felt constrained not only to cover fully the lecture content, but also to present it at least as efficiently as a live lecturer would. This sometimes requires trying to devise small-screen analogies to lecture techniques like explaining a large, complicated diagram or table that integrates a great deal of information. A lecturer would focus audience attention by pointing with a laser pointer to the pertinent regions of the projected image, would verbally develop each concept at length, and would relate each to other elements or to the overall picture as needed. The image would always remain before the audience as an organizational framework. It seemed important to mimic the essence of this style in CAI, and it seemed inappropriate to rely on the innate strengths of CAI, such as repeatability, multipath linking and problem solving in the hope of compensating for some less comprehensible and less efficient style of primary presentation.

We have considered three kinds of information: 1) narrative (text), 2) tables and 3) pictorial material such as sequences of metabolic intermediates in a pathway or diagrams schematizing mechanisms of processes. In all cases, our CAI development has attempted to reflect the lecturer's style of organizing material, rather than attempting to force the lecturer into a new mold or to develop concepts from an altogether different perspective. This seems important, not only to assure the cooperation of the highly autonomous faculty, but also to avoid frustrating the already overworked students, who expect to be held responsible for everything in the lectures, and who might become confused by a style unlike what they had seen previously in lecture. (Many students choose to use CAI in addition to lecture, rather than as a lecture replacement.) Predictably, CAI development sometimes leads to visual aids more effective than those previously available to the lecturers, and these may find their way into the live presentations.

Our way of incorporating interactivity and user control, while dealing with the information density/cluttered screen issue, is to use the *show* and *hide* commands of HyperCard. Major points of information are presented in bold typeface, and serve as advance organizers for the details, which are typically in pop-up fields revealed by clicking on the boldfaced information. Any object revealed by clicking can be hidden by clicking on it. A check mark appears to indicate that the object has been viewed, and the check remains if the user hides it away.

Narrative. A typical example of narrative development is shown in Figure 1. Panel A shows a screen prior to revealing details under the boldfaced major points, and Panel B shows the same screen after the details have been shown by clicking. Note the check marks. The ability to hide and show fields allows students to test their memories with mental drill.

The rectangles on the right of the screen are buttons which give the student access to the feature named, such as a textbook reference, behavioral objective, an overview screen listing all topics, *etc*.

Figure 2 illustrates a text node. It consists of topics in underlined boldface type. Clicking on any of these items reveals more information on another screen. Any of this information may be further developed on subsequent screens.

In all of these examples, the boldfaced material is contained in locked fields which are programmed to cause the appropriate event, such as showing a field containing details in plain text, when the mouse button is clicked while the cursor is within their boundaries. The fields containing plain text are programmed to hide themselves if clicked upon. Curiously, use of field programming in this manner has been ignored in some books on HyperCard, but it makes a natural user interface with text.

Fields can contain only one font in one size and style, but Greek letters, subscripts and related effects can be produced by layering separate transparent fields over one another. It then becomes necessary for the programmer to assure that clicking on any one of such a set of fields will produce the desired effect. The user will expect that clicking anywhere in a homogeneous-looking body of information will have the same effect, and will be vexed if chance clicking on a small field containing a subscript fails to do the same thing as clicking on the rest of the text.

Tables. Good design of tables requires no more than four items at any level of subdivision (Willey and Jarecky, 1976). Within these constraints it is nevertheless possible to make large, complicated tables, which leave little or no screen space for explaining their contents. One way of dealing with this problem is to reveal the table piece by piece, using the blank space available before the table is fully shown for explanation of the information already showing. Figure 3 A illustrates a table as it appears initially. The segment which shows is explained in boldface, inviting the user to click on it. Figure 3 B shows the same table after two rounds of clicking to reveal successively more information. Note the two corresponding check marks. Clicking on the newly revealed information would hide it, and clicking on the new boldfaced type would show additional material.

In this example the table is a HyperCard graphic, drawn entirely with paint tools, rather than text in fields. The boldfaced text is in overlaying opaque fields programmed to hide themselves upon clicking, thereby revealing the underlying table segment. Simultaneously a transparent button over the newly revealed portion of the table is shown. The button is programmed to hide itself and to show the corresponding boldfaced field. Proper layering of objects is critical for making this sequence operate correctly.

Another approach to developing tabular information is shown in Figure 4. Here points requiring explanation are in boldfaced fields programmed so that clicking on them puts details into the rectangle at the bottom of the table. Clicking on other boldfaced fields replaces the contents of the rectangle with other details, and clicking on the rectangle empties it altogether. Notice that one cell of this table contains boldface underlined material. Clicking here expands this cell, giving the student more information on another screen.

Choice of the technique to use depends in part on the importance of sequencing the information. In the table of Figure 4, the sequence is not critical. The conventions of the English language (left to right, top to bottom) are adequate cues; further, exploring this table in a "non-ideal" sequence would be unlikely to cause confusion. In the table of Figure 3, on the other hand, the desired sequence of study is forced by the programming.

Pictorial Material. Pictorial material resembles tabular information in that the problem is to build a detailed story without losing the overview; again, correct sequencing of information presentation may be important.

Figure 5 A-C illustrates one solution to this problem. Panel A shows the screen as it first appears; only the starting point, glucose, is visible. Subsequently the elements in panel B are revealed in the sequence indicated by the direction of the arrows, so the pathway appears to grow before the user's eyes. The effect is accomplished by placing empty, opaque fields over the information that is to be shown sequentially, then hiding these opaque fields with the screen locked, and finally unlocking the screen with a "wipe left slowly" or a "wipe right slowly" command, depending on the direction in which progression is desired. In keeping with our convention, clicking on boldfaced material reveals details, as shown in panel C. Since the user shows these details actively, there is no possibility of becoming confused as to which detail goes with which main point, as would be the case if panel C were the first thing the user saw. Information that should be merely a reminder of facts already known is placed in fields revealed with a "mouse within" command. For example, students are expected to recognize that ***PK*** abbreviates "pyruvate kinase," but a reminder is available by touching ***PK*** with the cursor (Figure 5 C). As soon as the cursor is moved away, the reminder disappears, avoiding unnecessary screen clutter.

A second approach is shown in Figure 6. Panel A shows a typical metabolic pathway with multiple interrelationships. Only one point is in bold type; clicking on it changes the screen appearance to what is shown in panel B, with a narrative development of the point as described above. Clicking on **Glycogen synthesis is active.** takes the user to another screen resembling Figure 6 B, except that now "Glycogen" would be in bold type. The user thus begins learning about each element of the diagram with the entire picture in view. The narrative material, of course, is always placed on the screen in a position that does not obscure the point under development. Consideration of Acetyl CoA, for example, which appears on the right-hand side of the screen, would be done on the left half of the screen.

Multistep transformations are not easy to describe effectively with static diagrams. The best a lecturer can do without invoking animation (which is not usually available to the average lecturer) is to show a sequence of slides, each depicting a separate stage. This tends to lose the broad view of the process. Computer animation solves the problem ideally, and in a way that cannot be approached with most lecture hall media.

Figure 7 A is a schematic diagram of a cell in which a process is about to be started by the binding of a hormone (agonist) to a receptor on the cell membrane surface. Figure 7 B shows the final state of the cell. The computer animates the process, so the user can see the agonist bind, the formation of intracellular intermediates, the migration of these intermediates to specific subcellular locations, and their immediate and final effects. Note, for example, how Ca^{++} has been released from storage, has bound to calmodulin, and how the Ca^{++}calmodulin complex has interacted with and activated the protein kinase. The student initiates this sequence on the screen, and can repeat it at will. ome of our students claim that it was not until they had seen the animation that they understood what was happening.

Programming a sequence like this involves showing and hiding fields with the screen locked, and then unlocking the screen with a "wipe left/right slowly" command, as was the case for the example of Figure 5. In addition, however, it is necessary to select and drag graphics in order to give the appearance of objects moving from place to place. To restore the screen so the student can repeat the sequence, a copy of the original state of the screen graphic, stored on a card that is never shown, is copied and pasted onto the screen, and the appropriate fields are hidden or shown.

Conclusion

Use of "show" and "hide" commands in HyperCard permits CAI developers to design programs that are not only interactive, but that allow the students to build a great deal of information into a single visual impression. Our experience with first year medical and graduate students in a Medical Biochemistry course shows that the students have no difficulty with this interface. Once they grasp the principles of clicking on bold faced information to reveal more information, and of clicking on newly revealed material to hide it, they have no difficulty in handling variations on these themes that may be necessary to achieve special effects.

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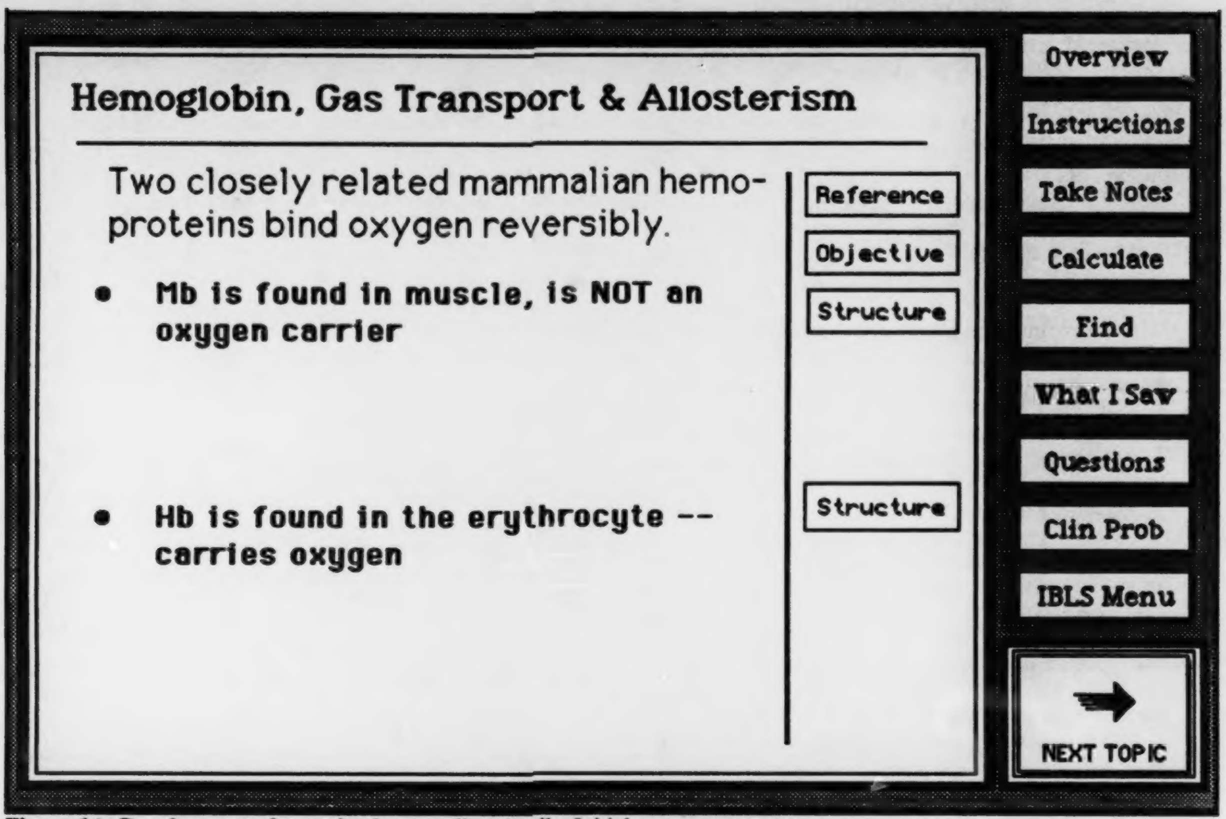
Willey, M. S. and Jarecky, B. M(1976). *Analysis and application of Information*. Association of American Medical Colleges.



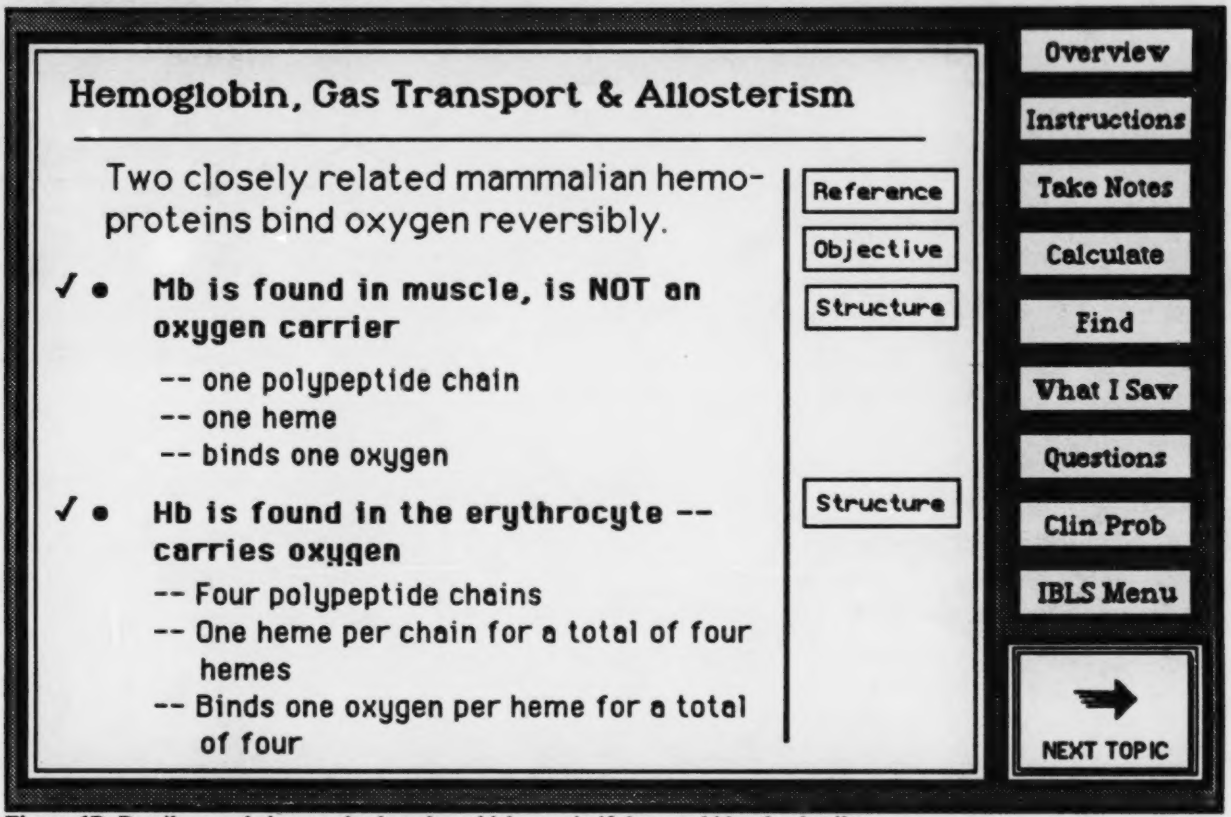
Hemoglobin, Gas Transport & Allosterism

Two closely related mammalian hemoproteins bind oxygen reversibly.

- **Mb is found in muscle, is NOT an oxygen carrier**
- **Hb is found in the erythrocyte -- carries oxygen**

Reference
Objective
Structure
Structure
Overview
Instructions
Take Notes
Calculate
Find
What I Saw
Questions
Clin Prob
IBLS Menu
NEXT TOPIC

Figure 1A. Development of narrative by revealing details. Initial screen appearance.



Hemoglobin, Gas Transport & Allosterism

Two closely related mammalian hemoproteins bind oxygen reversibly.

✓ • **Mb is found in muscle, is NOT an oxygen carrier**

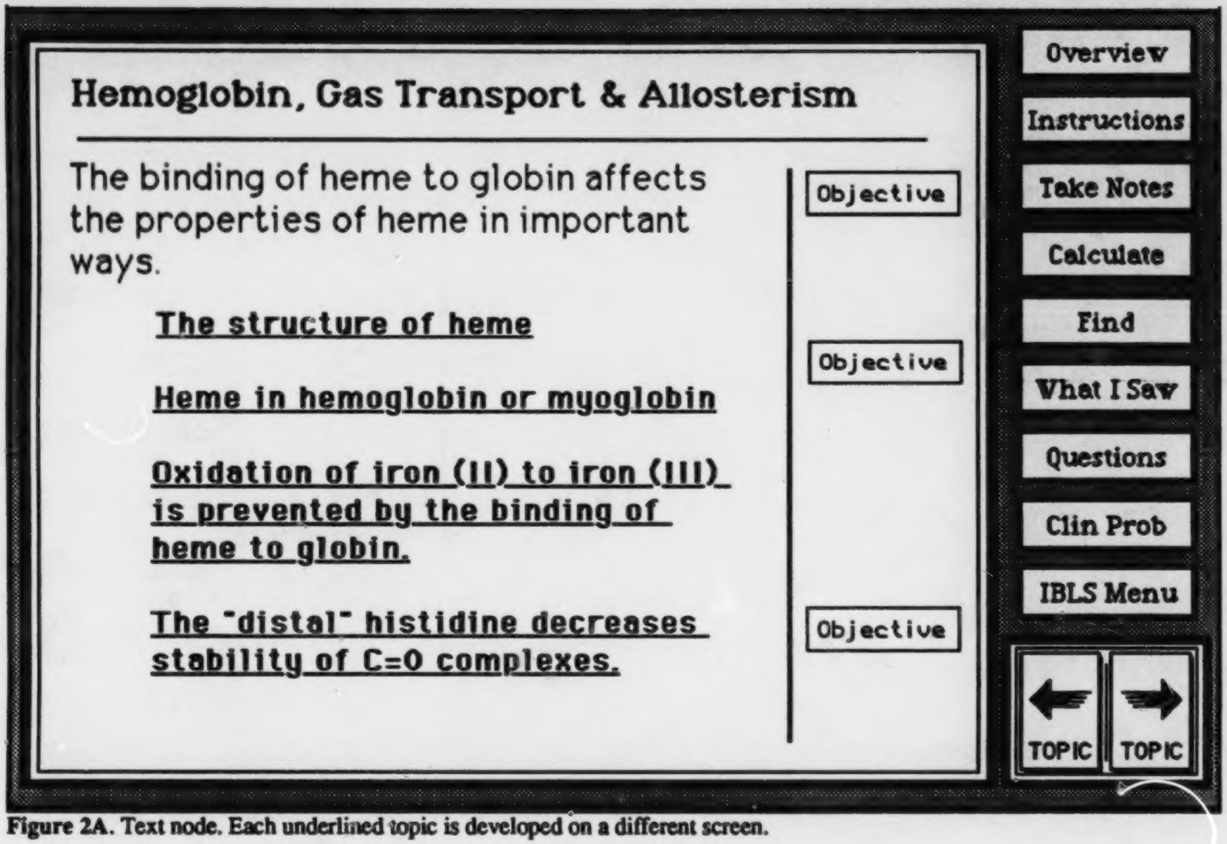
-- one polypeptide chain
-- one heme
-- binds one oxygen

✓ • **Hb is found in the erythrocyte -- carries oxygen**

-- Four polypeptide chains
-- One heme per chain for a total of four hemes
-- Binds one oxygen per heme for a total of four

Reference
Objective
Structure
Structure
Overview
Instructions
Take Notes
Calculate
Find
What I Saw
Questions
Clin Prob
IBLS Menu
NEXT TOPIC

Figure 1B. Details revealed; note checkmarks, which remain if the user hides the details.



Hemoglobin, Gas Transport & Allosterism

The binding of heme to globin affects the properties of heme in important ways.

The structure of heme

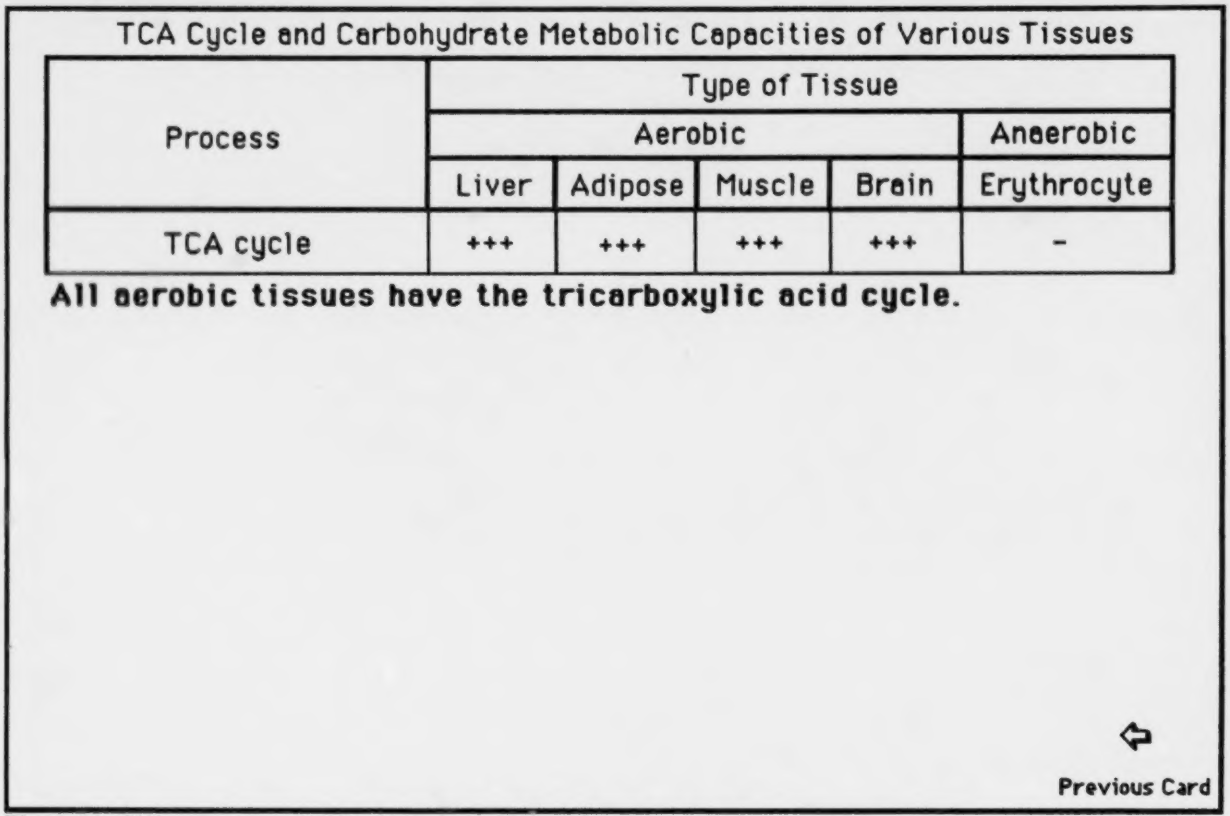
Heme in hemoglobin or myoglobin

Oxidation of iron (II) to iron (III) is prevented by the binding of heme to globin.

The "distal" histidine decreases stability of C=O complexes.

Objective
Objective
Objective
Overview
Instructions
Take Notes
Calculate
Find
What I Saw
Questions
Clin Prob
IBLS Menu
TOPIC
TOPIC

Figure 2A. Text node. Each underlined topic is developed on a different screen.

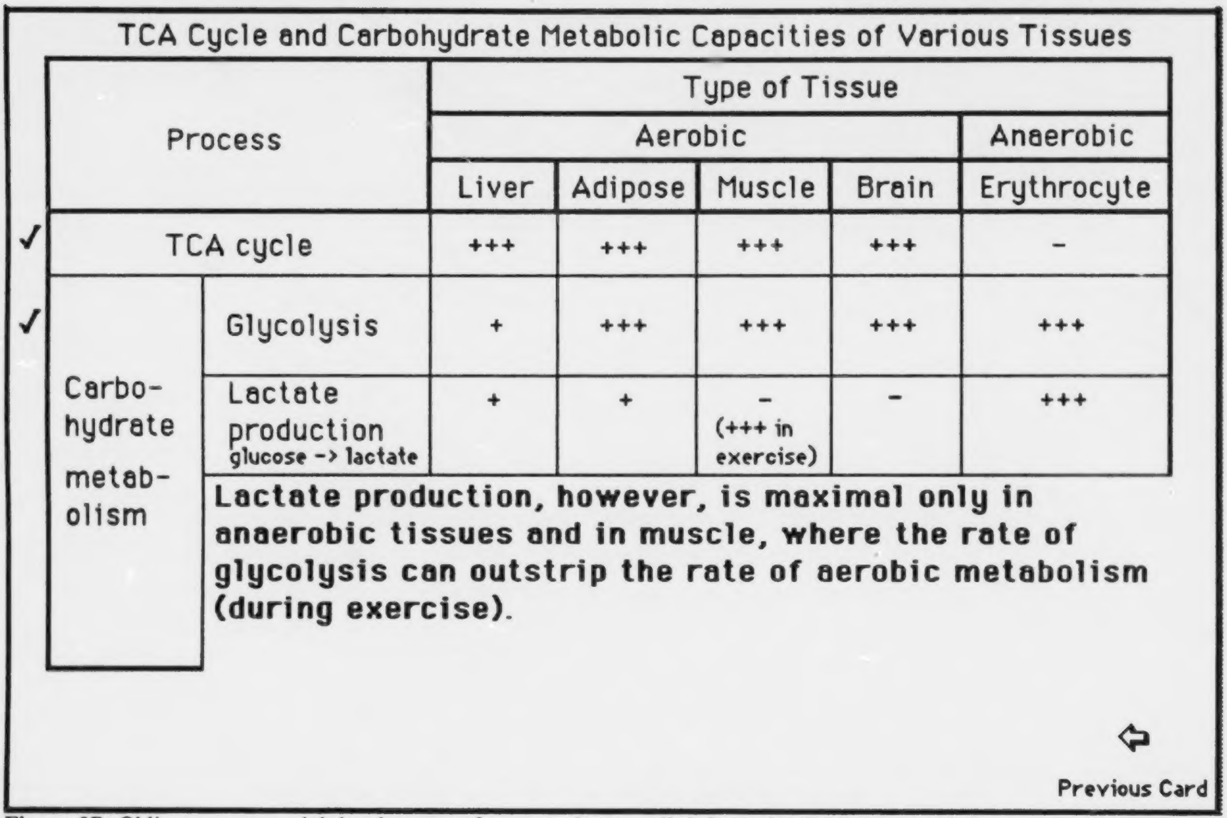


TCA Cycle and Carbohydrate Metabolic Capacities of Various Tissues

Process	Type of Tissue				
	Aerobic				Anaerobic
	Liver	Adipose	Muscle	Brain	Erythrocyte
TCA cycle	+++	+++	+++	+++	-

All aerobic tissues have the tricarboxylic acid cycle.

Figure 3A. Obligatory sequential development of tabular information. Initial screen appearance.

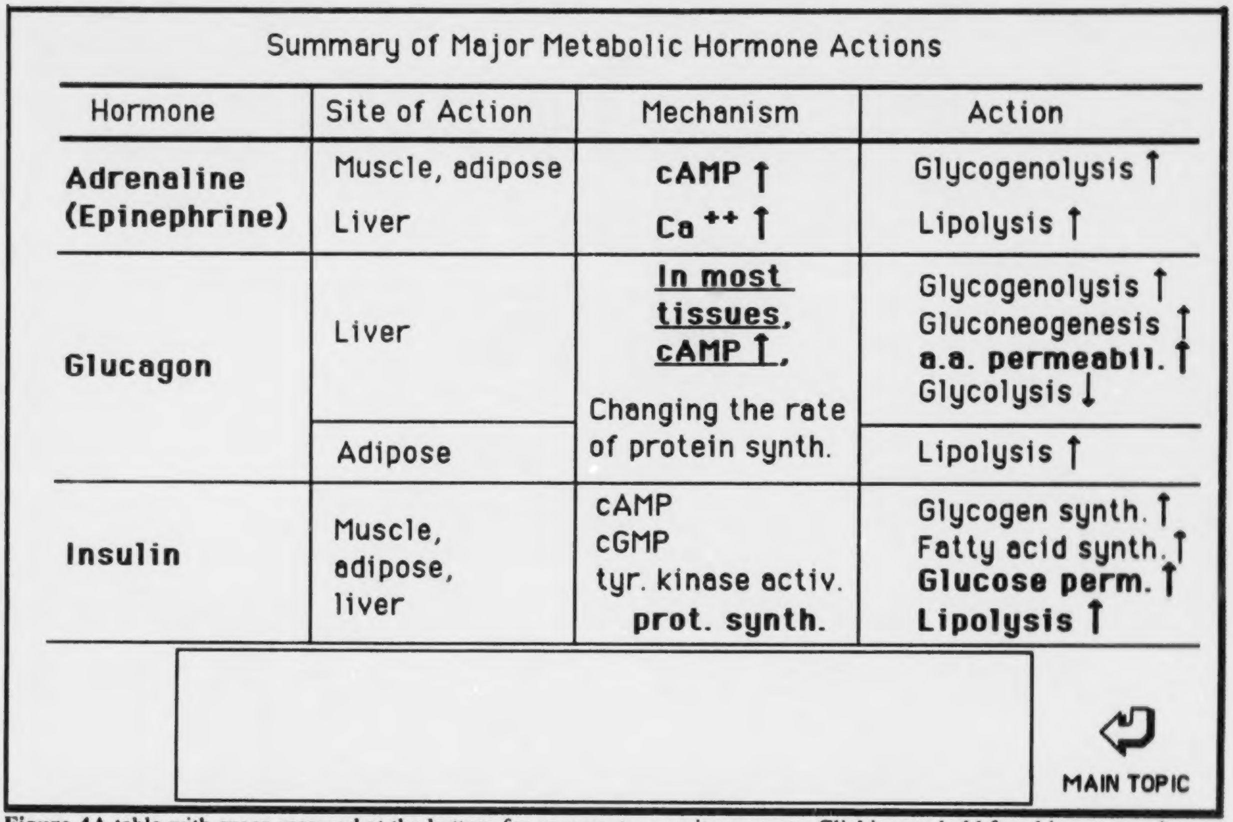


TCA Cycle and Carbohydrate Metabolic Capacities of Various Tissues

	Process		Type of Tissue				
			Aerobic				Anaerobic
			Liver	Adipose	Muscle	Brain	Erythrocyte
✓	TCA cycle		+++	+++	+++	+++	–
✓	Carbohydrate metabolism	Glycolysis	+	+++	+++	+++	+++
		Lactate production glucose -> lactate	+	+	– (+++ in exercise)	–	+++

Lactate production, however, is maximal only in anaerobic tissues and in muscle, where the rate of glycolysis can outstrip the rate of aerobic metabolism (during exercise).

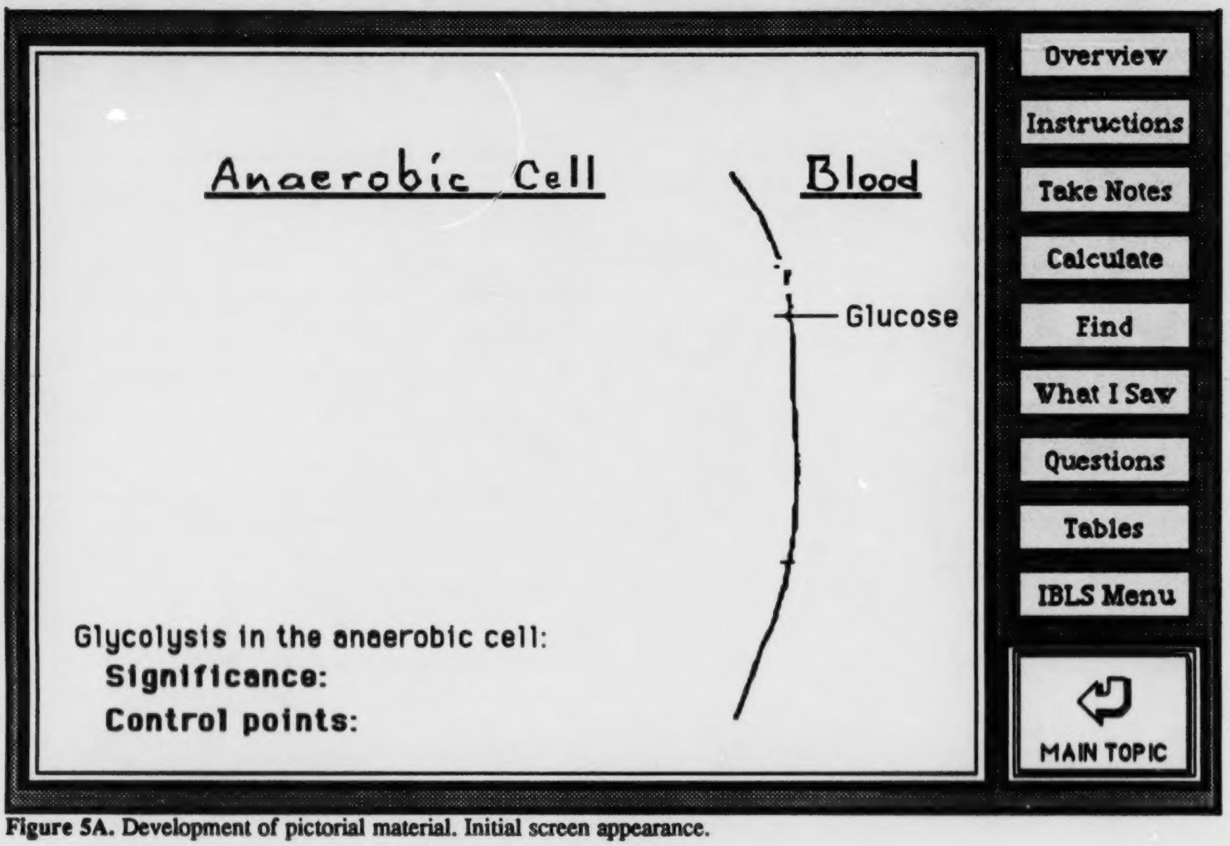
Figure 3B. Obligatory sequential development after some, but not all, information has been revealed.



Summary of Major Metabolic Hormone Actions

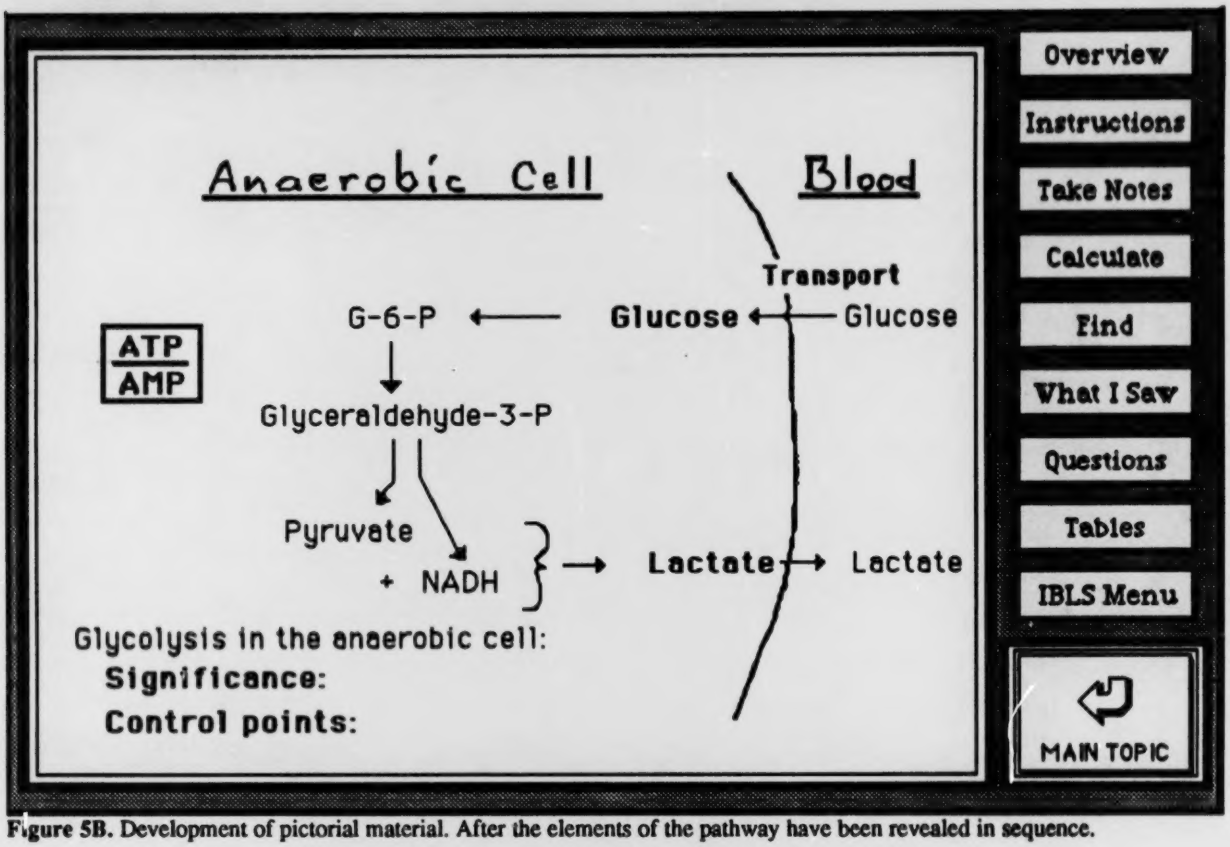
Hormone	Site of Action	Mechanism	Action
Adrenaline (Epinephrine)	Muscle, adipose Liver	**cAMP ↑** **Ca^{++} ↑**	Glycogenolysis ↑ Lipolysis ↑
Glucagon	Liver	**In most tissues, cAMP ↑,** Changing the rate of protein synth.	Glycogenolysis ↑ Gluconeogenesis ↑ **a.a. permeabil. ↑** Glycolysis ↓
	Adipose		Lipolysis ↑
Insulin	Muscle, adipose, liver	cAMP cGMP tyr. kinase activ. **prot. synth.**	Glycogen synth. ↑ Fatty acid synth. ↑ **Glucose perm. ↑** **Lipolysis ↑**

Figure 4A table with space reserved at the bottom for commentary on its contents. Clicking on bold faced items reveals appropriate comments in the reserved space.


Anaerobic Cell
Blood
Glucose
Overview
Instructions
Take Notes
Calculate
Find
What I Saw
Questions
Tables
IBLS Menu
MAIN TOPIC

Glycolysis in the anaerobic cell:
Significance:
Control points:

Figure 5A. Development of pictorial material. Initial screen appearance.

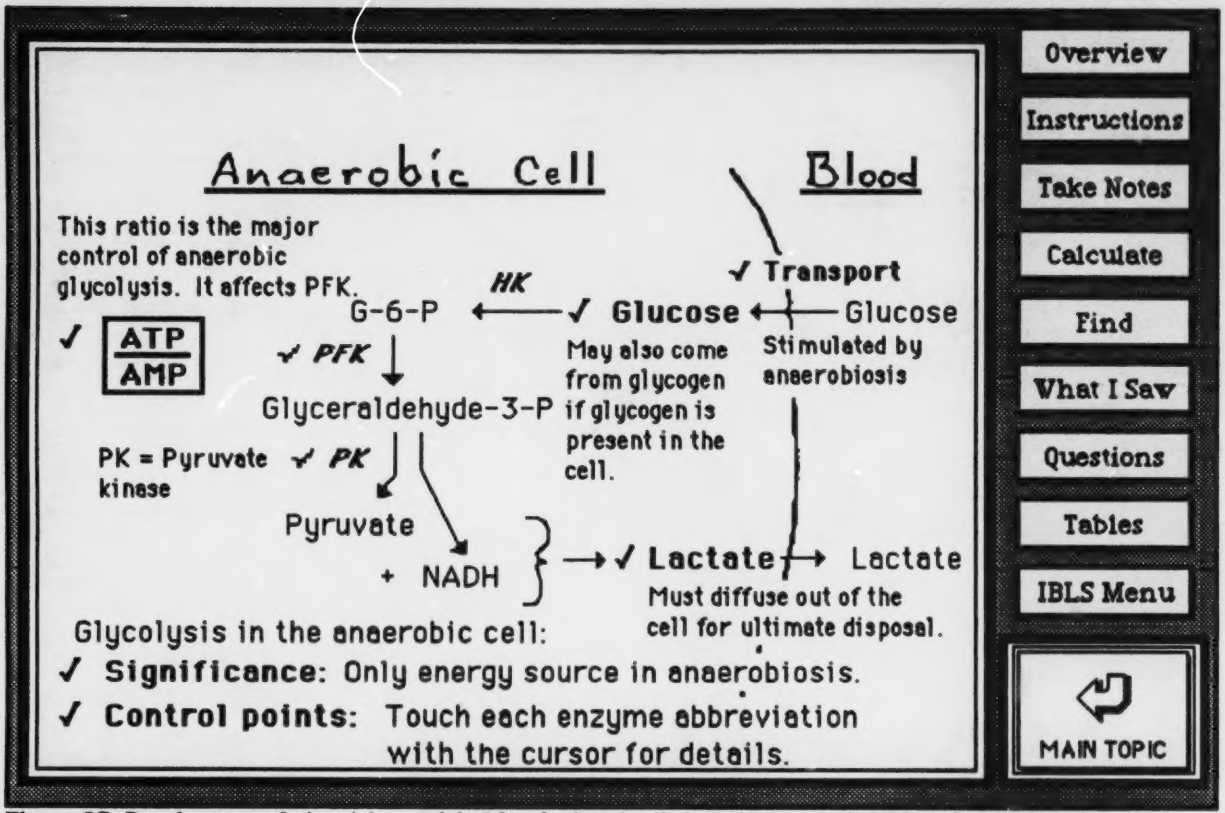

Anaerobic Cell
Blood
Transport
G-6-P
Glucose
Glucose
ATP
AMP
Glyceraldehyde-3-P
Pyruvate
+ NADH
Lactate
Lactate
Overview
Instructions
Take Notes
Calculate
Find
What I Saw
Questions
Tables
IBLS Menu
MAIN TOPIC

Glycolysis in the anaerobic cell:

Significance:

Control points:

Figure 5B. Development of pictorial material. After the elements of the pathway have been revealed in sequence.



Anaerobic Cell

Blood

This ratio is the major control of anaerobic glycolysis. It affects PFK.

May also come from glycogen if glycogen is present in the cell.

Stimulated by anaerobiosis

PK = Pyruvate kinase

Must diffuse out of the cell for ultimate disposal.

Glycolysis in the anaerobic cell:

✓ **Significance:** Only energy source in anaerobiosis.

✓ **Control points:** Touch each enzyme abbreviation with the cursor for details.

✓ ATP/AMP
HK
G-6-P
✓ Glucose
✓ Transport
Glucose
✓ PFK
Glyceraldehyde-3-P
✓ PK
Pyruvate
+ NADH
✓ Lactate
Lactate
Overview
Instructions
Take Notes
Calculate
Find
What I Saw
Questions
Tables
IBLS Menu
MAIN TOPIC

Figure 5C. Development of pictorial material. After further details have been revealed. Note the checkmarks, which remain if the user hides the details.

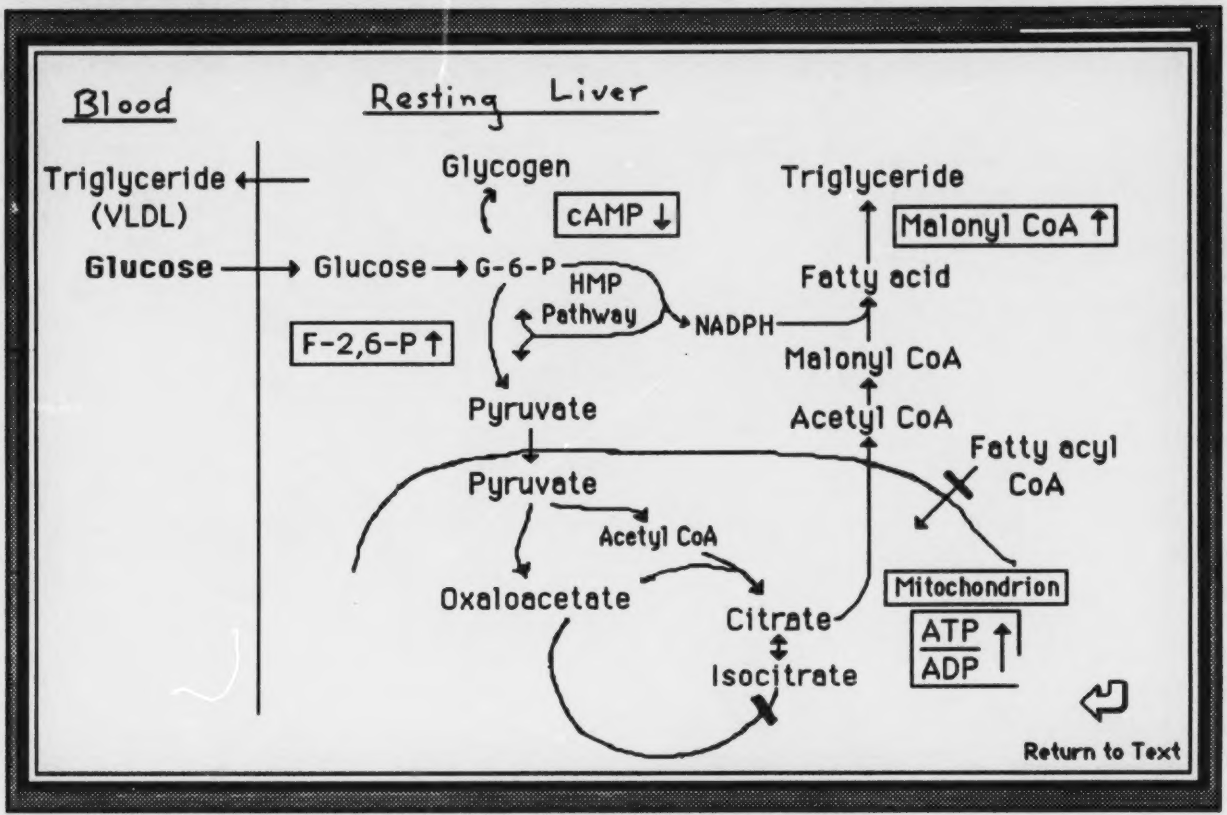
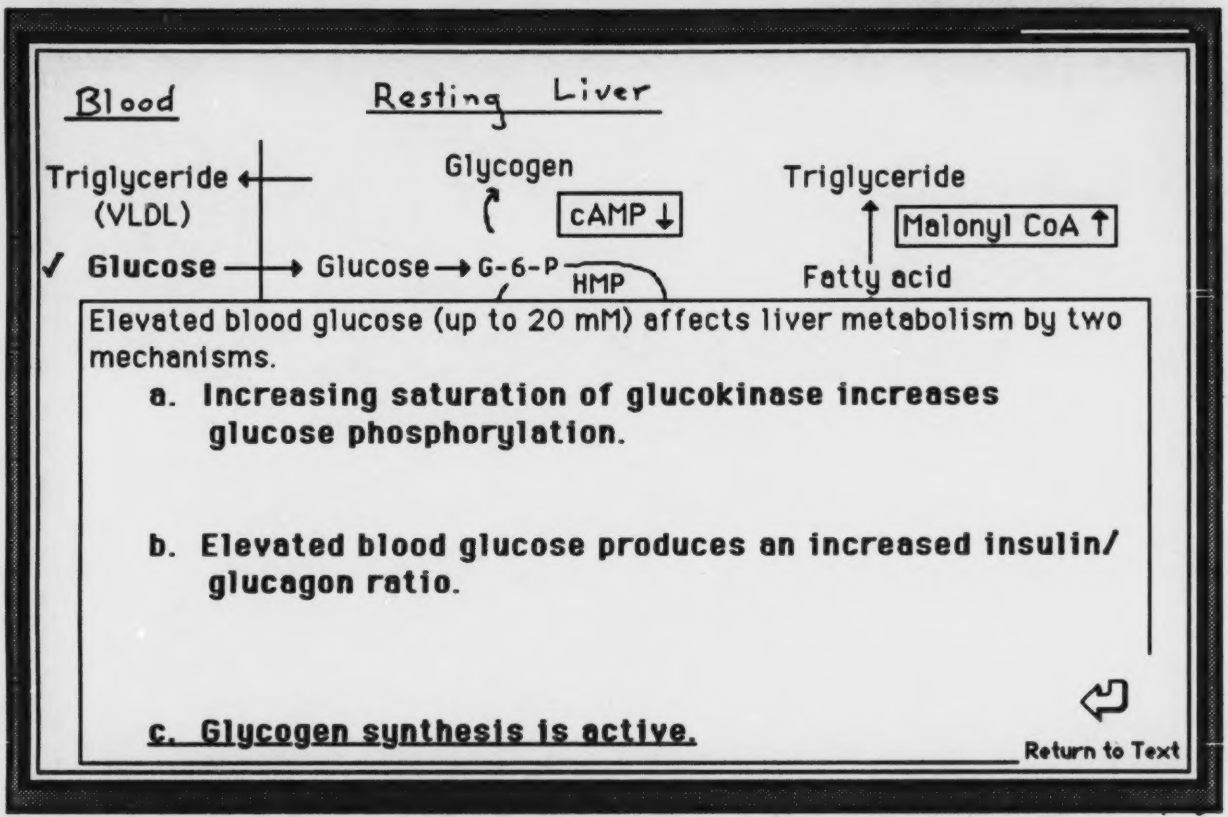

Blood
Resting Liver
Triglyceride
(VLDL)
Glucose
Glucose
G-6-P
Glycogen
cAMP ↓
HMP
Pathway
NADPH
F-2,6-P ↑
Pyruvate
Pyruvate
Acetyl CoA
Oxaloacetate
Citrate
Isocitrate
Triglyceride
Malonyl CoA ↑
Fatty acid
Malonyl CoA
Acetyl CoA
Fatty acyl
CoA
Mitochondrion
ATP
ADP
Return to Text

Figure 6A. Combination of narrative and pictorial development. Initial screen appearance.


Blood
Resting Liver
Triglyceride
(VLDL)
✓ Glucose
Glucose
G-6-P
HMP
Glycogen
cAMP ↓
Triglyceride
Malonyl CoA ↑
Fatty acid
Return to Text

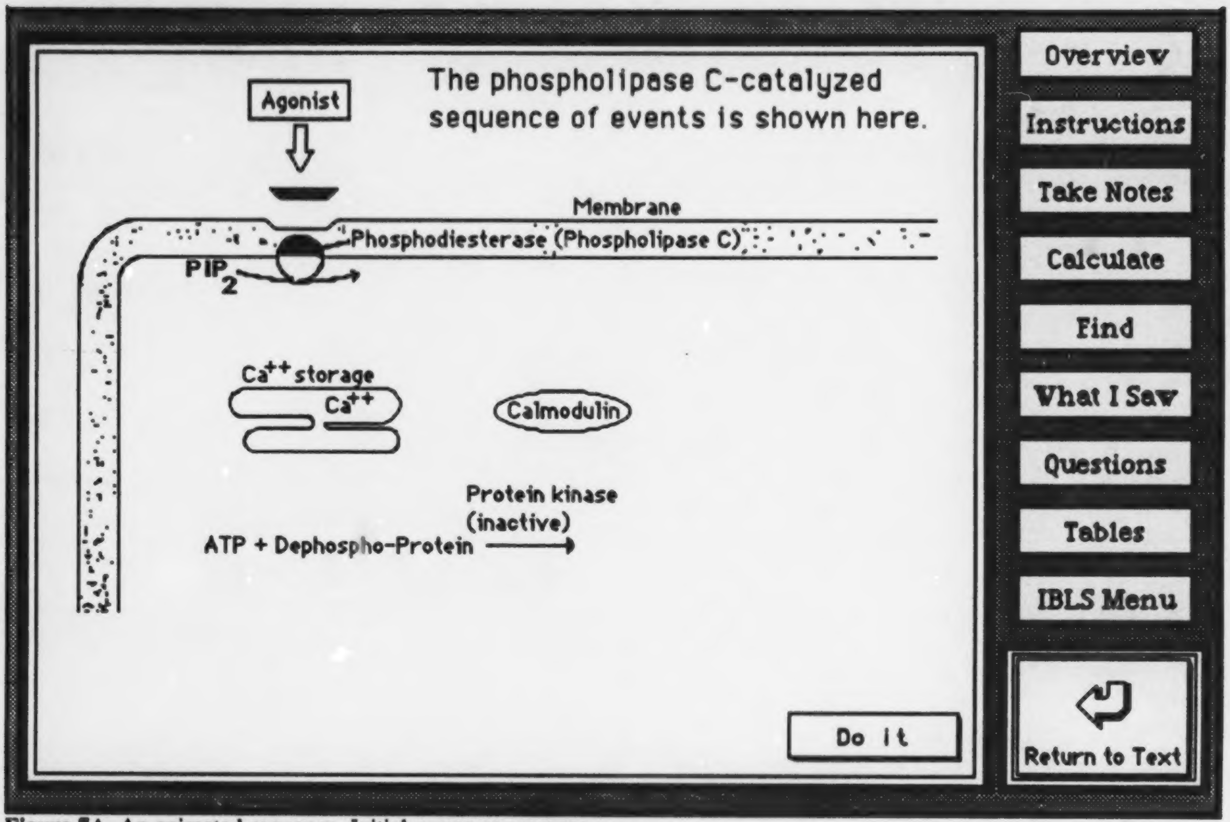
Elevated blood glucose (up to 20 mM) affects liver metabolism by two mechanisms.

a. **Increasing saturation of glucokinase increases glucose phosphorylation.**

b. **Elevated blood glucose produces an increased insulin/ glucagon ratio.**

c. **Glycogen synthesis is active.**

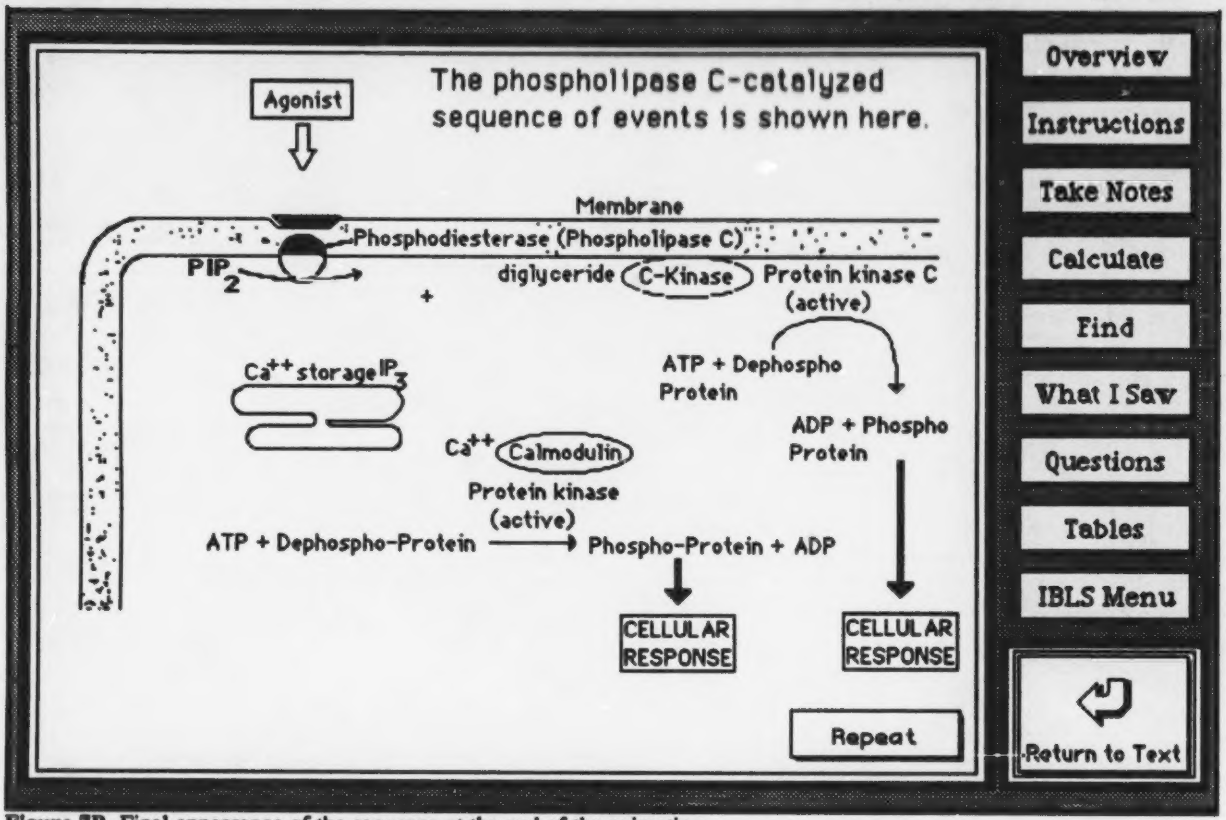
Figure 6B. Combination of narrative and pictorial development. Narrative which appears after clicking on Glucose.



The phospholipase C-catalyzed sequence of events is shown here.

Agonist
Membrane
Phosphodiesterase (Phospholipase C)
PIP2
Ca++ storage
Ca++
Calmodulin
Protein kinase
(inactive)
ATP + Dephospho-Protein
Do it
Overview
Instructions
Take Notes
Calculate
Find
What I Saw
Questions
Tables
IBLS Menu
Return to Text

Figure 7A. An animated sequence. Initial screen appearance.



The phospholipase C-catalyzed sequence of events is shown here.

Agonist
Membrane
Phosphodiesterase (Phospholipase C)
PIP$_2$
diglyceride
C-Kinase
Protein kinase C (active)
+
Ca^{++} storage
IP$_3$
ATP + Dephospho Protein
ADP + Phospho Protein
Ca^{++}
Calmodulin
Protein kinase (active)
ATP + Dephospho-Protein
Phospho-Protein + ADP
CELLULAR RESPONSE
CELLULAR RESPONSE
Repeat
Overview
Instructions
Take Notes
Calculate
Find
What I Saw
Questions
Tables
IBLS Menu
Return to Text

Figure 7B. Final appearance of the sequence at the end of the animation.

HYPERMEDIA FOR EDUCATION

Ann Barron, Analysis & Technology; and Donna Baumbach, University of Central Florida

Abstract

This paper discusses repurposing an educational videodisc using three different hypermedia programs: LinkWay for MS-DOS computers, HyperCard for Macintosh, and Tutor Tech for Apple// computers. Comparisons made among the three environments include the flexibility, structure, ease of authoring, and required design changes.

Introduction

The notion of using a machine to provide connections between several pieces of information originated with Vannevar Bush in 1945A small amount of work was done in this area in the 1960's and 1970's, but it was not until recently that hypermedia and hypertext became "household" words.

The most common meaning of hypertext is a database that has active cross-references and allows the reader to 'jump' to other parts of the database as desired" (Shneiderman & Kearsley, p. 3). Hypermedia, on the other hand, "goes beyond the concept of text" (Stevens & Stevens, p. 6). The information in a hypermedia database might be text, graphics, sound, or video. This information can be linked together using a hypermedia software application program, and it can be accessed in associative, nonlinear ways.

The recent popularity of hypermedia can be attributed to the increased access to computers and to the availability of hypermedia software such as HyperCard. These software programs make authoring easier and have "the potential to give back to teachers the control they lately have ceded to software programmers" (Trotter, p. 35).Teachers can now provide a wealth of instructional materials that can adapt to individual student interests.

Although there are many application programs now on the market for hypermedia development, this paper will address three that are of special interest to educators. These three (HyperCard for the Macintosh, Tutor Tech for the Apple // family, and LinkWay for MS-DOS machines) are all inexpensive and relatively easy to use. They offer tremendous potential for teacher-created instructional programs.

System Requirements

HyperCard is distributed free with new Macintosh computers. It requires 1 megabyte of RAM and 2 floppy drives. It can be run on a Mac Plus, Mac SE, Mac II, or any of the other new models. For the comparison study, a Mac SE was used (with a 20 MB hard drive). The HyperCard program is required for development and delivery.

Tutor Tech is distributed by Techware Inc. of Altamonte Springs, Florida. The cost is $195, which includes one teacher diskette and license to create up to 50 student diskettes. Tutor Tech will run on an Apple //e, //c, or GS with at least 128K RAM. One floppy drive is required, although two are recommended. A hand control (such as a mouse, joystick, or koala pad) is required for the development, however the program can be delivered with either keyboard or hand control inputs. Delivery can be on a color or monochrome monitor.

LinkWay is available from IBM and retails at approximately $110 (A substantial discount is offered to educators.) Included in the price are additional programs for editing text, producing graphic images, and editing fonts. A free runtime delivery program is available upon request. LinkWay is able to run on almost any IBM PC or PS/2, or compatible computer. Although it can be created in modes up to VGA, the minimum requirements are 384K RAM and a CGA card. A mouse is required for both development and delivery. See Figure 1 for a summary of the system requirements.

Figure 1. Minimum System Requirements

	HyperCard	Tutor. Tech	LinkWay
Computer	Macintosh	Apple IIe, IIc, GS	IBM
RAM	1 Mb	128 k	384 k
Display	Standards	Mono	CGA
Input	Mouse	Hand Control (Development)	Mouse

Similarities

All three of the application programs contain the same basic structure, with slightly different terminology. Each screen in HyperCard and Tutor Tech is called a card, whereas in LinkWay they are referred to as pages. A collection of cards then becomes a stack (HyperCard, Tutor Tech) or a folder (LinkWay). Each system also allows for the creation of objects on the screen, which are either buttons, fields, or graphics. In addition, all of the programs can access and control videodisc players.

Another similarity is the variety of levels of user access. Both HyperCard and LinkWay have five levels of control, ranging from total "freedom" for the author or developer to "read-only" for the student. The Tutor Tech program has 2 levels of control, determined by whether the Teacher Disk or Student Disk is the boot disk. All of the systems allow the author to easily change from one level to another to "preview" the lesson from a student's perspective.

The creation and importation of graphics is an integral part of all of the systems. HyperCard has built-in paint tools similar to MacPaint. These tools are quite extensive with features such as fat-bits and stretching. Of course a wide variety of clip art may also be imported through the clipboard.

The paint program in Tutor Tech is object oriented and more limited, with features of rectangles, circles and lines. However, there are many different colors and patterns available, and the graphics may be cut and pasted between cards or stacks. A sample disk is provided with the program that contains a variety of clip art, and it is easy to import graphics from programs such as Newsroom and Print Shop.

Graphics are created in LinkWay in a supplemental program called LWPaint. This program may be accessed from within LinkWay or from DOS. It is an "easy-to-use drawing application packed with standard features like pencil, line, box, circle, and text" (Pogue, p. 38). However, it does not provide many of the more sophisticated features such as the ability to stretch or shrink graphics. To provide more flexibility, LinkWay includes a program called LWCapture. This is a memory resident program that can be used to capture any graphic screen of the same mode. LWCapture saves the image in a LinkWay format, which can be edited later with LWPaint and called directly into LinkWay. All graphic files in LinkWay are stored as external picture files, which are read from disk when needed for display. Another similarity among the systems is the function of the buttons. In all three programs, the button is the primary object used to initiate action (such as branching to another card or calling a video sequence). In all cases, the button can be visible or invisible and can be almost any rectangular size and shape.

Differences

A major difference between the programs is the script or language levels (see Figure 2). In HyperCard, the language is Hyper. Talk. It consists of an "English-like" language with 80 different commands and functions, and it is extremely powerful. Hyper. Talk can be used to create scripts for stacks, cards, buttons, fields, or backgrounds. Animation is created with either a sequence of show cards or by choosing a menu tool from within a script. HyperCard is the only program of the three with commands for visual effects (such as wipe and dissolve).

There is a similar script language in LinkWay, which has about 40 built-in commands and functions"In certain ways it is similar to BASIC or Fortran" (Harrington, p. 283). In LinkWay, scripts can be written only for buttons, and they operate similar to the mouseUp message in Hyper. Talk.

Figure 2. System Differences

	HyperCard	Tutor. Tech	LinkWay
Commands	80	Embeded	40
Animation	Show Cards	Wait	Toolkit
Fields	Flexible	None	Restricted
Graphics	Bit Map	Object	Bit Map
User Access	5 levels	2 levels	5 levels

The openStack message in HyperTalk corresponds to the conditions for executing the LinkWay AUTOEXEC button script (a unique button that is activated when the folder is opened). Animation is possible in LinkWay with the purchase of an additional program called LinkWay Toolkit. Tutor Tech does not contain a script language; however, commands can be embedded on the card that will activate when the card is opened. For example, the command •2• 12345SE 12355PL, will search for frame 12345 and play through frame 12355 each time the card is opened. Since this command cannot be written as a script for a button, video can only be accessed when a card is opened. A similar embedded command can be used to produce animation as the result of a series of "wait" commands.

Another major difference among the systems is the structure of the fields (a block of text that is treated as an object). Fields in HyperCard are quite flexible — they may be resized and easily repositioned. Fields in LinkWay are much more restricted, with no word wrap or automatic reformatting. Tutor Tech does not have fields per se. Instead, text is created using the text input for the object-oriented graphics. Each line of text is then addressed as a graphic. Fields in HyperCard can use one of many text sizes; in both LinkWay and Tutor Tech there are four sizes. The differences required for videodisc control are illustrated in Figure 3. n most cases, the HyperCard video drivers are purchased separately from a company such as Voyager or Apple. The example scripts on the chart reflect the Voyager commands. The Voyager stack contains drivers for several models of Sony, Pioneer, and Hitachi players.

Figure 3. Video Access

	HyperCard	Tutor. Tech	LinkWay
Port	Modem	Serial/ Modem	Serial
Set Baud	Voyager	Dip Switches	DOS Mode
Initialize	Video Init	•2• SA	1 line script
Search	Search, xx	•2• xxSE	Serial 1, "xxSE";
Play	Play, till, xx	•2• xxPL	Serial 1, "xxPL";

Video in Tutor Tech is accessed via a serial card or (for a GS) the MODEM port. The embedded command •2• SA refers to the slot of the serial card (in this case slot 2). Tutor Tech can also access a videotape player via a BCD box.

LinkWay accesses the videodisc player via the serial port. The DOS mode command (Mode Baud=4800, in the case of DOS 4.0) can be used to set the baud rate. A button containing 9 lines of script is provided with LinkWay to initialize the player(This button can be placed in the AUTOEXEC button of the opening folder.) Access of the video consists of a single line of code as represented in the chart.

Design

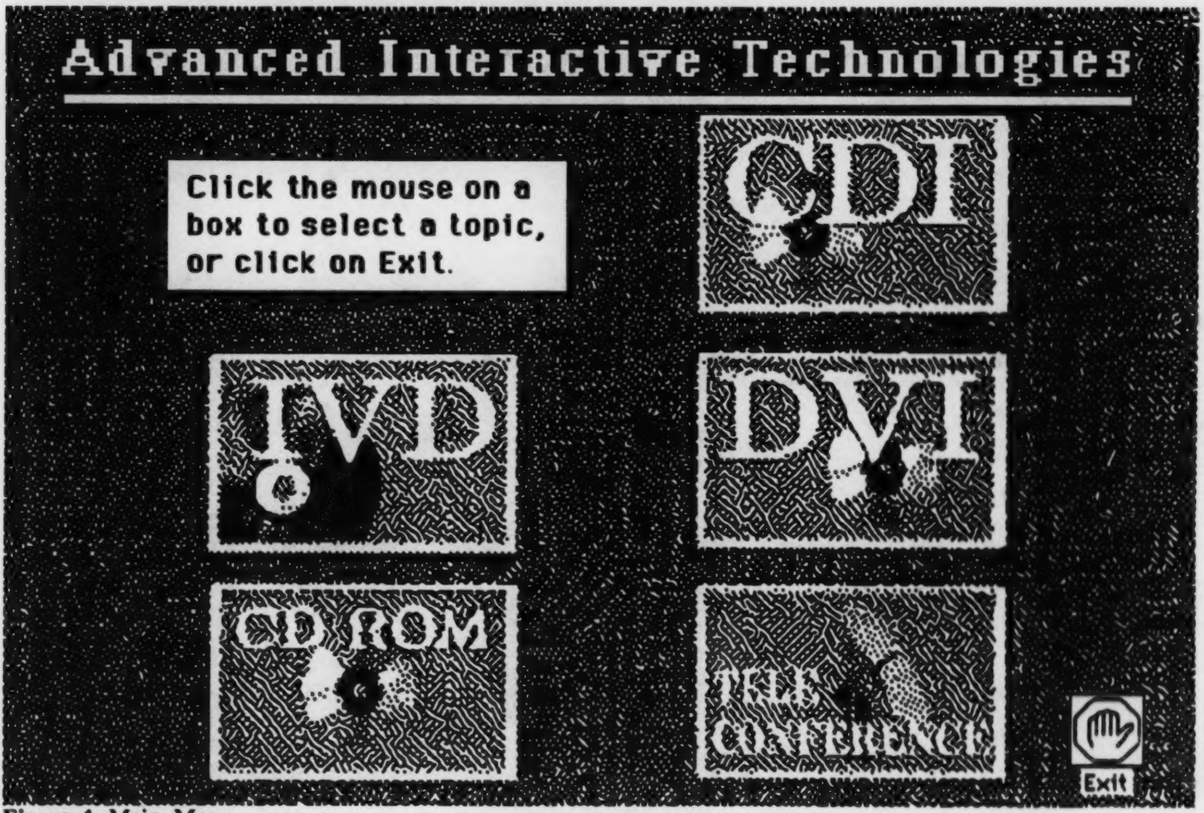
To provide a realistic comparison, the three hypermedia programs were each used to repurpose the Advanced Technologies Disc by the National Science Center for Communications and Electronics (NSCCE). This videodisc was produced by NSCCE for Level I delivery and contains the following five chapters.

1. CD-ROM - Compact Disc-Read Only Memory
2. IVD - Interactive Videodisc
3. CDI - Compact Disc Interactive
4. DVI - Digital Video Interactive
5. Teleconferencing

To provide consistency between the visuals on the video monitor and the computer monitor, the Main Menu of the videodisc was digitized, buttons were added, and it then became the Main Menu of the HyperCard stack (see Figure 4). The program is designed so that whenever the user returns to the computer Main Menu, a still frame of the Main Menu of the videodisc will appear on the video monitor.

Utilizing a tutorial strategy, the resulting Level III design features a submenu for each chapter with an Overview, Configuration, and Applications section (see Figure 5). Sections can be accessed in any order, and they branch to a combination of motion video sequences, video still frames, and computer displays. Each segment concludes with a summary of the computer and one or two optional questions. Maximum learner control is provided with permanent options such as Review, Continue, Return to Menu and Exit. In addition, video segments can be repeated.

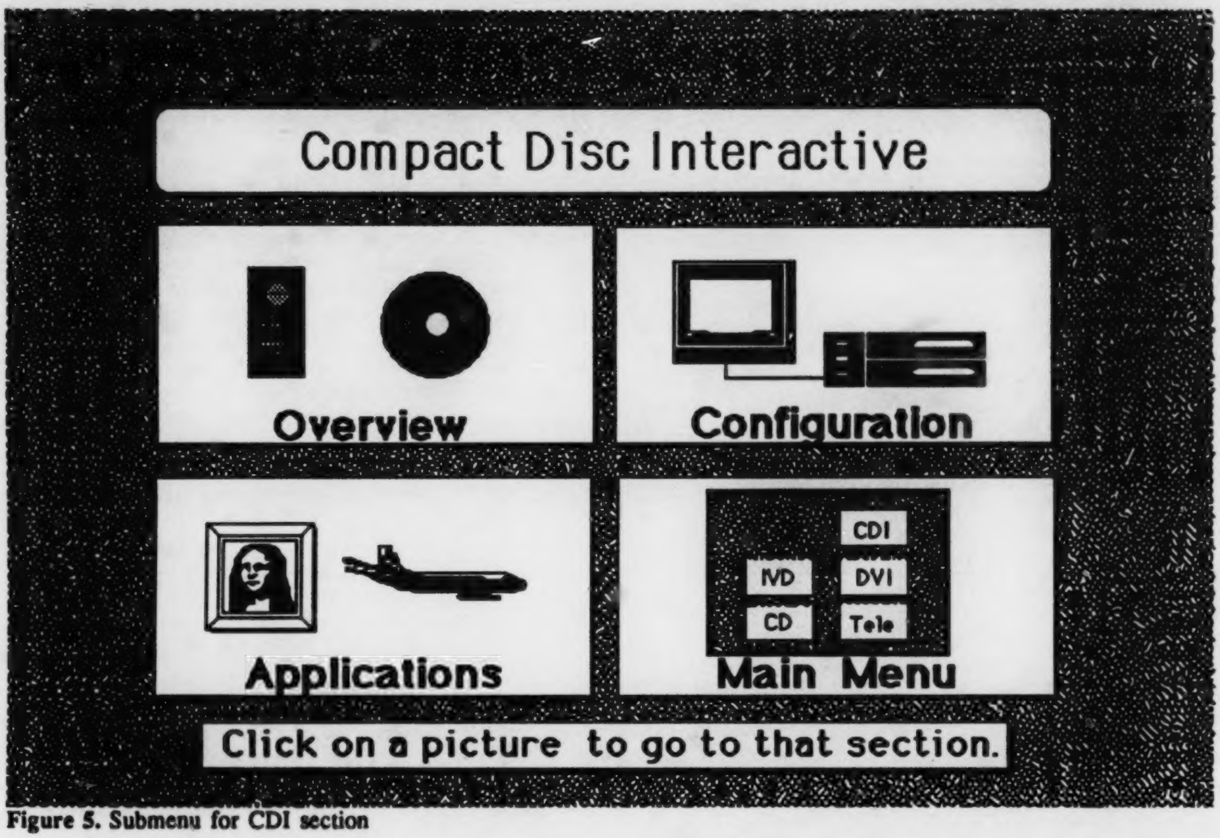
The "overview" sections furnish an introduction to each technology by providing general information and by highlighting unique features. A definition of terms is included to allow the learner to become familiar with the terminology associated with each technology. Motion video segments introduce each section and then branch to graphics and text screens on the computer.



Advanced Interactive Technologies

Click the mouse on a box to select a topic, or click on Exit.

Figure 4. Main Menu


Compact Disc Interactive

Click on a picture to go to that section.

Figure 5. Submenu for CDI section

The "configuration" sections for each technology provide a diagram of the necessary hardware. Each component part is identified and described (see Figure 6 for an IVD configuration screen). If the videodisc contains footage for the configuration, it is also accessed.

The "applications" sections highlight several areas of use for each technology. The learner may choose to read the text screen which describes the applications, or they may view them in "action" by accessing the examples provided on the videodisc. In the IVD and CD-ROM segments, the address and telephone number of several publishers are also provided for those seeking further information.

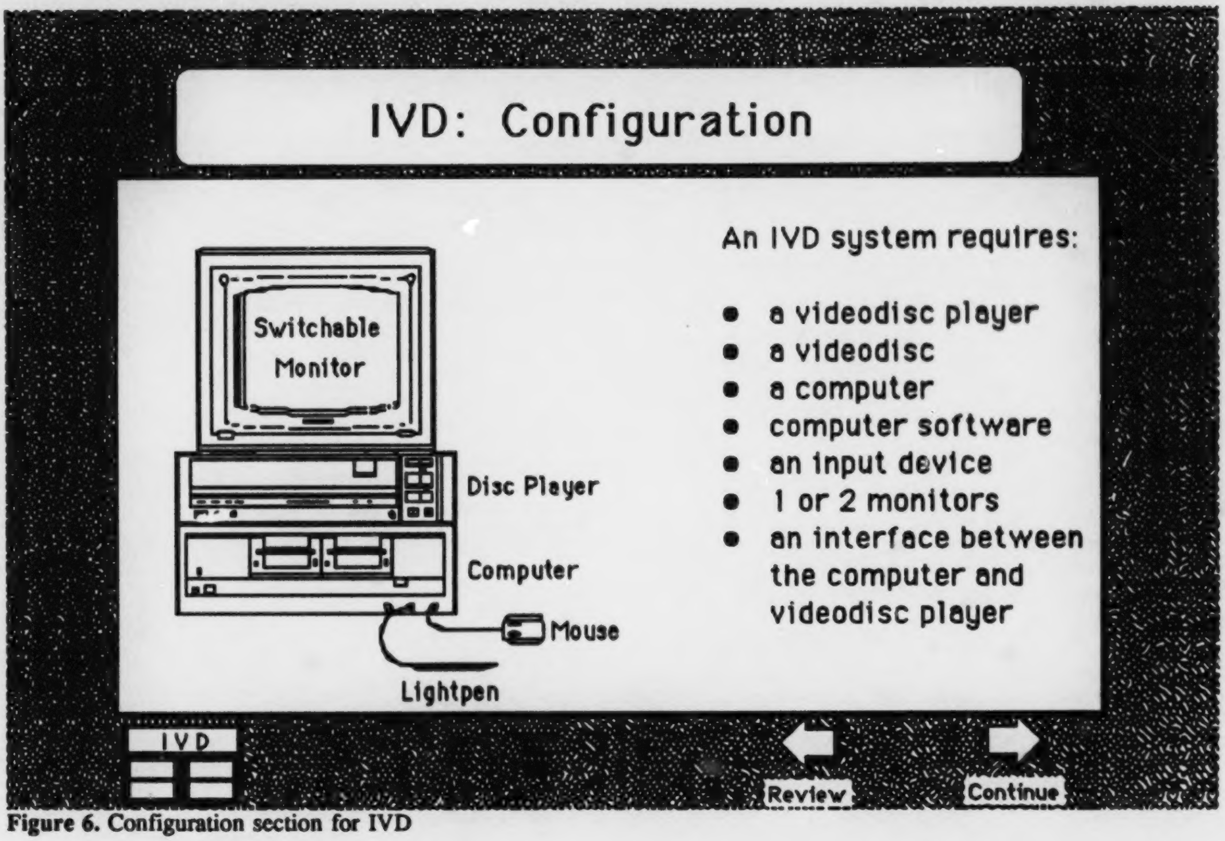
Development

It was relatively easy to maintain the majority of the design features throughout the three development efforts. Basic graphics and buttons were duplicated, and the branching remained quite consistent. Because Tutor Tech can only access video when a card opens, a few additional cards had to be created in that version. (In the other versions, video was sometimes accessed via a button, without branching to another card.)

An advantage of HyperCard is that a video still can be called in the openCard command of a card script. This feature was used to return to a specific still frame whenever the learner returned to the main menu, etc. In LinkWay, only buttons can access video; therefore, each button that branched to the menu had to have the video script in it. In the Tutor Tech version, it was easy to access the still frame when the card opened; however, some cards had to be duplicated because the first time the card was accessed was at the end of a motion sequence; subsequent times required only a still frame.

The picture pop-up and text pop-up features are unique to LinkWay. Although they can be simulated in HyperCard with scripts, they are not nearly as easy to incorporate. These features were added to the design in the LinkWay version. There are no similar features, and no scripts to create them, in Tutor Tech.

For remediation and feedback, the answer command (HyperCard) and the message command (LinkWay) are almost identical. They automatically provide a pop-up window on the screen with only one line of script. There is no corresponding feature in Tutor Tech. For that version, the student was branched to another card for remediation. Tutor Tech does have a built-in motivational card feature for the correct answer. This displays a special card for a period of 2 seconds before returning to the program. Tutor Tech also keeps score of the number of correct and incorrect answers and displays the final score when the student exits.



IVD: Configuration

An IVD system requires:

- a videodisc player
- a videodisc
- a computer
- computer software
- an input device
- 1 or 2 monitors
- an interface between the computer and videodisc player

Figure 6. Configuration section for IVD

System Features and Limitations

From a developer's point of view, the best features of HyperCard are its shortcuts with keystrokes, the hypermap or recent option, the Hyper. Talk language, and the field flexibility. Especially useful to the computer-based author are the answer commands and the hilite property. They allow the incorporation of feedback and the tracking of student progress. The major limitation of HyperCard is the limitation of a Mac SE — a small black and white screen.

LinkWay's attributes include its color (which can be CGA, MCGA, EGA, or VGA), the picture pop-up feature, and the external graphic files. By creating external files for the graphics and objects, it is very easy for the author to revise segments and cut and paste objects without going back into the original page. The limitations noted in LinkWay include the XOR colors, the lack of shortcuts for the pull-down menus, and the character cell alignment of fields.

The outstanding features of Tutor Tech are its ease of authoring and its flexibility of delivery. Because there is no underlying language, this system is extremely easy to learn and use. It serves as a good introduction to hypermedia, without the frustration of learning a language. The fact that Tutor Tech can be delivered with or without a mouse on an Apple //e, //c, or GS allows for a large delivery audience. In addition, Tutor Tech is the only program of the three that has a built-in management system to keep the students' score. The limitations of Tutor Tech include the "bleeding" of the colors caused by the Apple // resolution, the predetermined sequence of button access for computers without a mouse, and the fact that the size of each stack is limited to 32K.

Conclusion

It is now possible for educators to create hypermedia programs whether they have an Apple//e with 128K, a Macintosh, or an IBM with only a CGA card. The tools are available which are both flexible and inexpensive. The possibilities for changing the way teachers teach and students learn are limited only by our imaginations.

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DESIGN TECHNIQUES FOR ENSURING STRUCTURE AND FLEXIBILITY IN A HYPERMEDIA ENVIRONMENT

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Abstract

A modified hypermedia approach was used during the development of an educational software program entitled *ATLAS plus* (Advanced Tools for Learning Anatomical Structure) at the University of Michigan Medical School. This approach allows the user both flexibility and structure within the same software program. The philosophy behind this approach, a brief description of the software program, specific examples of the design features created, and expectations of users' needs are discussed.

Introduction

The use of hypermedia in educational settings has quickly captured the imagination of educators and instructional designers from elementary through higher education. Newly emerging technologies have allowed software developers to challenge the constraints of traditionally defined computer assisted instruction, allowing users the flexibility to navigate through content and functions in a manner unique to each individual (Frisse, 1990). In medical education, this has resulted in numerous projects designed to deliver large amounts of textual, graphic and image material in efficient and easily accessible formats. The opportunity to deliver content so efficiently has distinct advantages in a field where the information students must learn increases exponentially each year. Additionally, more and more medical schools across the country are shifting the focus of their curricula to reflect the need to teach students to be lifelong learners; that is provide more student directed, student generated learning activities. To this end medical educators are currently using or developing hypermedia programs to teach basic science material, such as anatomy (Zagari, 1989) and pathology (Tessler, 1990), as well as clinical problem solving, diagnostic techniques (Greenes, 1986) and decision making (Greenes, 1986).

Students in the medical school environment are a relatively homogeneous population; they are generally high performing as well as highly motivated learners. There are, however, students who enter medical school who may not fit this stereotypical mold. The standard curriculum which requires that students sit in lectures and laboratories all day for two years before spending two years in clinical experiences may not be the most effective teaching method for reaching this group.

The purpose of this paper is to describe an educational software program that was developed to meet the needs of all types of learners; essentially it established structure within a hypermedia type environment. This structure does not imply merely a linear approach to the content. Instead, the links and associations among screens, modules, and content have been anticipated by the content experts and designers. The software developers are, in a sense, predicting any additional information that students of varying sophistication might need and providing easy access to that content. This guided approach to the content represents the foundation for the design philosophy underlying the software development. A description of the project will be provided, with a focus on various design techniques for applying this philosophy to the creation of educational software.

Software Description

ATLAS plus, Advanced Tools for Learning Anatomical Structure, is a teaching tool reflecting a modified hypermedia approach to the study of the anatomical sciences. The software program integrates the use of digitized images, pictures, computer graphics, sounds, animations and textual information to dynamically teach basic concepts and principles of several anatomy disciplines. *ATLAS plus* operates on a Macintosh IIcx ethernet network.

Tutorials in histology (epithelium, connective tissue, bone structure and growth, muscle), embryology (development of the human face, teratology), and gross anatomy (respiratory system, digestive system, nervous system) have been developed to date. Additionally, several laboratory introductions to histology have been completed, as well as data banks of drill and review questions, and a comprehensive examination program.

The primary authoring tool used was Authorware Professional by Authorware, Inc. Additionally, HyperCard (Apple Computer, Inc.), SuperCard (Silicon Beach Software), Modern Artist (Computer Friends), and Macromind Director (Macromind) were used to supplement the authoring system. This allowed a variety of functionalities while creating and maintaining a seamless environment for the user.

Design Techniques

A variety of design techniques was established to be used consistently across all modules of the software program. Again, all were devised to allow both flexibility as well as structure for the user. The following sections address several of these techniques in detail.

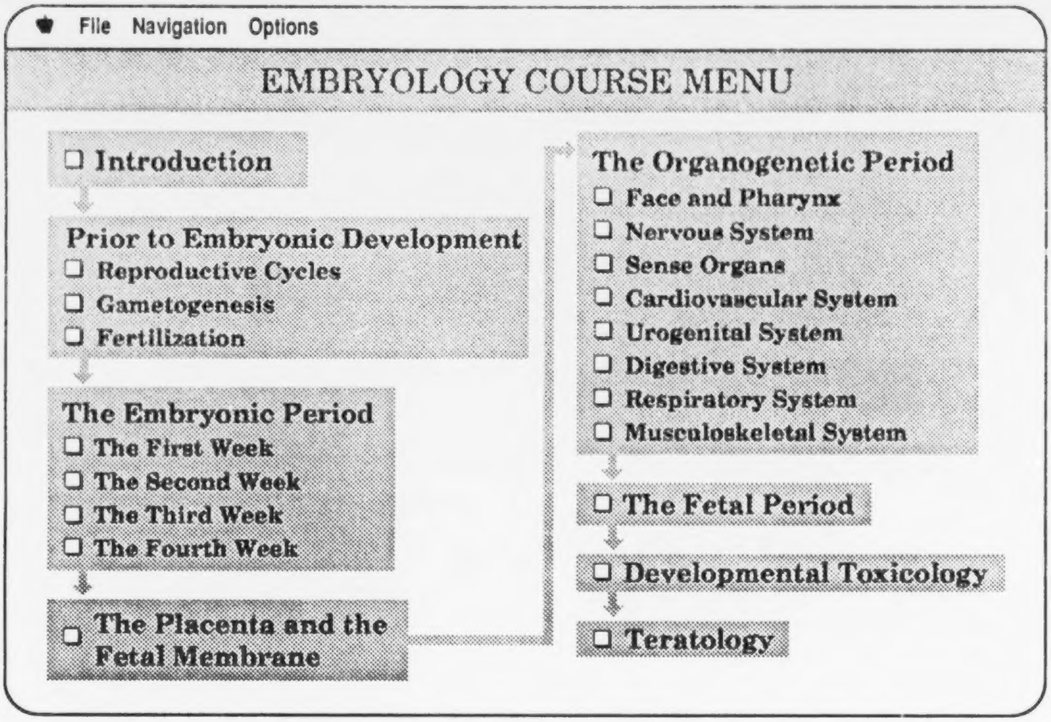

File
Navigation
Options
EMBRYOLOGY COURSE MENU
☐ Introduction
Prior to Embryonic Development
☐ Reproductive Cycles
☐ Gametogenesis
☐ Fertilization
The Embryonic Period
☐ The First Week
☐ The Second Week
☐ The Third Week
☐ The Fourth Week
☐ The Placenta and the Fetal Membrane
The Organogenetic Period
☐ Face and Pharynx
☐ Nervous System
☐ Sense Organs
☐ Cardiovascular System
☐ Urogenital System
☐ Digestive System
☐ Respiratory System
☐ Musculoskeletal System
☐ The Fetal Period
☐ Developmental Toxicology
☐ Teratology

Figure 1.

Menus

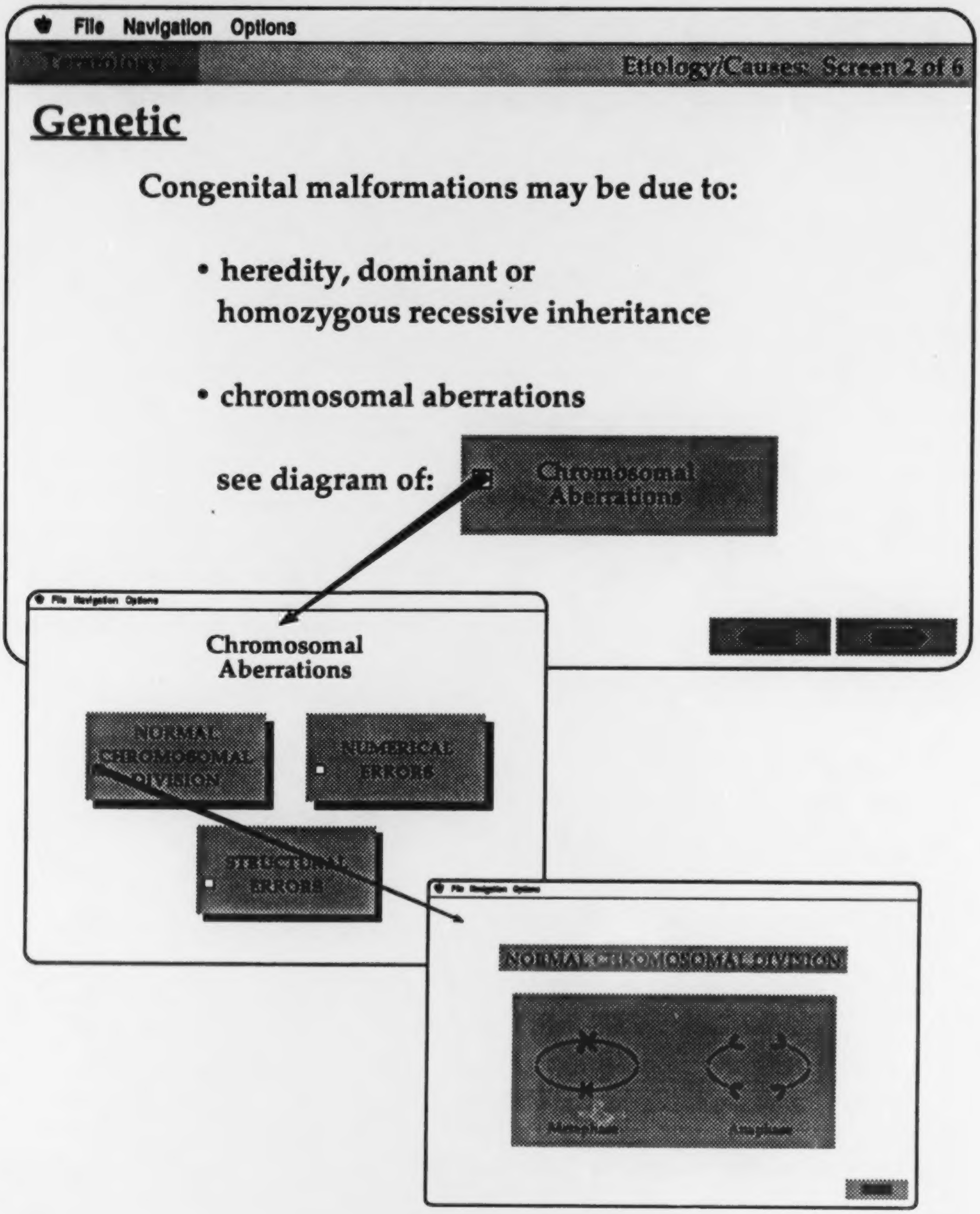
A menu system was developed to facilitate and allow the user to take either a structured path through the lessons or operate in a hypermedia fashion, jumping from component to component in any order. Each lesson is broken down into a number of components, each component accessible from a main lesson menu. Normally the lesson menu is designed so that a suggested path is apparent. For example, a menu might have component options listed in a top-down fashion implying that the user start with the top option and move through each module in order. This is to insure that all components are covered in the order desired by the instructor. Or a menu might present component options in a circular or rectangular arrangement, again suggesting an order with a beginning and an ending clearly indicated. Often lesson components are broken down into sub components, each accessible from another sub menu, designed to cue the user to a structured path. Sub menus and sub components can run several levels deep, but all follow the same pattern of designating a lesson path.

Dividing the lessons into components and further into sub components accomplishes two things: first, components are kept to a reasonable length, and second, users can jump easily into specific areas of a lesson. Thus, because components are accessible by menu, and because students can select any menu option available on a screen, they can easily use the menu options to get to a specific lesson component instead of tediously paging through a lesson.

Directories

Directories, like menus, provide the user with some degree of control over the navigational sequence through the material presented. At a very basic level, use of a directory can complement and improve the rigid page turning nature of a linear, screen by screen presentation by allowing the learner to exit the linear presentation at any time and re-enter it at another spot of his or her choice. At more complex levels, additional options which build on the user's level of expertise and increase user control can be integrated into the directory. An example from *ATLAS plus* will be used to illustrate this point.

One of the components of *ATLAS plus* is a series of laboratory introductions. These lab introductions are designed to introduce students to the cells and tissues that they will be viewing under the microscope during their actual laboratory sessions. Digitized images are displayed along with accompanying textual explanations which highlight the important structures or tissues. First time users of the lab introductions are encouraged to proceed through these lessons in a systematic, serial manner, starting with the first image and simply paging



File Navigation Options
Teratology
Etiology/Causes: Screen 2 of 6

Genetic

Congenital malformations may be due to:

- heredity, dominant or homozygous recessive inheritance
- chromosomal aberrations

see diagram of:

Chromosomal Aberrations
File Navigation Options

Chromosomal Aberrations

NORMAL CHROMOSOMAL DIVISION
NUMERICAL ERRORS
STRUCTURAL ERRORS
File Navigation Options
NORMAL CHROMOSOMAL DIVISION
Metaphase
Anaphase

Figure 2.

through until all the images have been seen. However, in subsequent uses of the laboratory introductions, students may wish to simply review images, thereby requiring a different strategy -- one that involves using a directory at increasingly sophisticated levels.

At the most basic level, a directory within a given lab introduction consists of a series of titles corresponding to images available to the user. There is no sequence of viewing imposed on the user, aside from the fact that the listing of the images is arranged from the simple to the complex. Selection of a given title will result in the display of the corresponding image and a routing of the user back to a point in the serial pathway where the associated textual explanation is displayed. From this point, a user may continue on to the next image on the serial path, go back to the previous image on the serial path, or return to the directory to make another selection. This mode of the directory is aimed at those students who require a detailed description of the image displayed, yet desire more flexibility in selecting specific images than the serial pathway alone allows.

Other dimensions of flexibility can be added to this basic directory to increase its level of functionality. For example, the designer may associate an option with each image title which, when invoked, simply displays the image without leaving the directory. This mode assumes that users are somewhat more familiar with the images in question and therefore need no accompanying textual explanations. It may be used effectively as a way for the user to informally self-assess his or her abilities to recognize certain images and to identify the important features.

The third and most complex dimension built into this directory is the ability to display and compare multiple images on a screen simultaneously. As each image is selected, it is displayed in a small window on the screen. Each of the small windows may be re-sized by the user. This mode assumes an even higher level of familiarity with the content, allowing the user to not only identify an image but also compare and contrast it to other similar images. Again, no explanatory text accompanies the images.

Animations

A number of the animation sequences in *ATLAS plus* are lengthy and describe complicated, multi-step processes. In these instances the animations are broken into several sections. The user may then choose to see each animation component in logical sequence or select an option to see the entire process animated in one continuous movie. The user may also play the animation components in any order to allow easy review of just one step in a given process, or opt to play a specific component several times in a row. Again, this design allows either a structured or freeform viewing of the material.

Contextual Framework

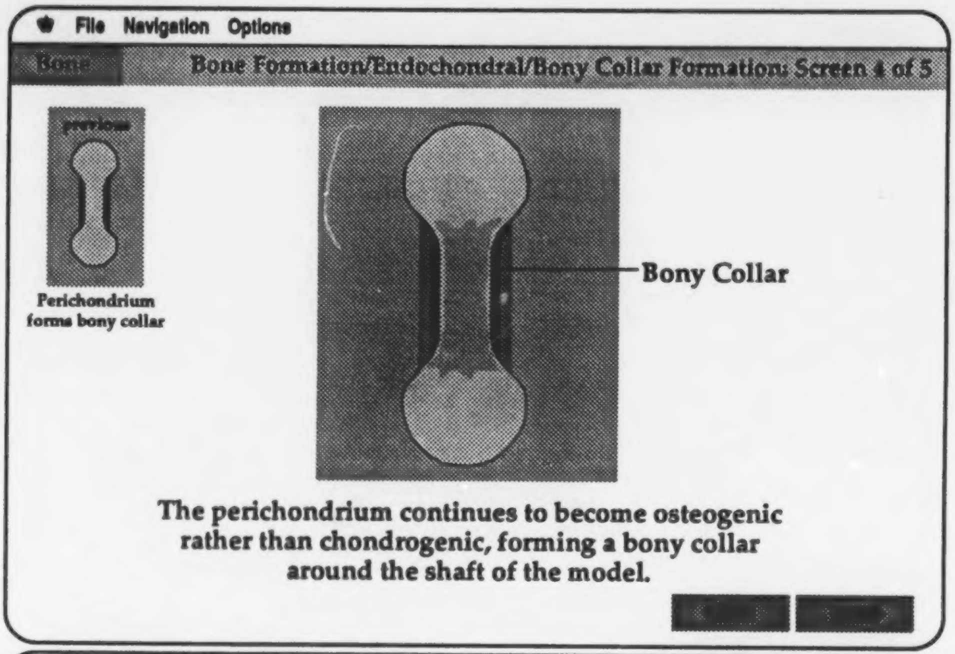
It is important for the user of a hypermedia application to understand his/her location in the lesson, both from a physical or navigational standpoint as well as from a content perspective. Various design techniques can be used to convey important contextual information. The purpose of this information is to define a set of expectations for the user which are reflective of the program's logical structure. It is the contextual framework then, that empowers the user while simultaneously helping to minimize confusion.

To provide a navigational context, the use of a reference bar is helpful. A reference bar posts the total number of screens in the module and the specific number of current screen being viewed. Using this device, the user is informed of his relative location in the module. Assuming that each screen averages the same amount of information, the user can estimate the length of the module based on the total number of screens. The approximate amount of information remaining can be calculated at any point in the lesson.

Information regarding content can also be relayed via the reference bar. For example, information in *ATLAS plus* is usually grouped into lessons which are often further divided into modules and sub-modules. Each reference bar indicates the lesson name, module name, and sub-module name to inform the user of his location from a content perspective. The content information in a reference bar might read as follows: "Face: 'Setting the Stage:' 'The Embryonic Face: Weeks 4-8.' " This tells the user that within the the "Face" lesson, s/he is in the section "The Embryonic Face: Weeks 4-8," which is a sub-module of the "Setting the Stage" module. Thus, contextual information as it relates to the general content of the exercise is provided. Merging the sense of navigational context with contextual context, the user may begin to chart a course through the lesson.

In *ATLAS plus*, a well-designed map of a given lesson can provide the user with 1) access to all choices at once, 2) the scope of content covered by each choice, and 3) a suggested order to follow (see Figure 1). This type of mapping structure, which provides mechanisms that both assist the user in determining "where" he is in a lesson, as well as informing him as to the options "ahead" of him, is an example of a design that promotes and allows effective and efficient database navigation. Navigational decisions that include content and/or time considerations on both a micro and macro level can be made. For example, limited by time, the user may decide to browse several large components covering familiar material, and then spend the bulk of his time on a unfamiliar, medium sized component.

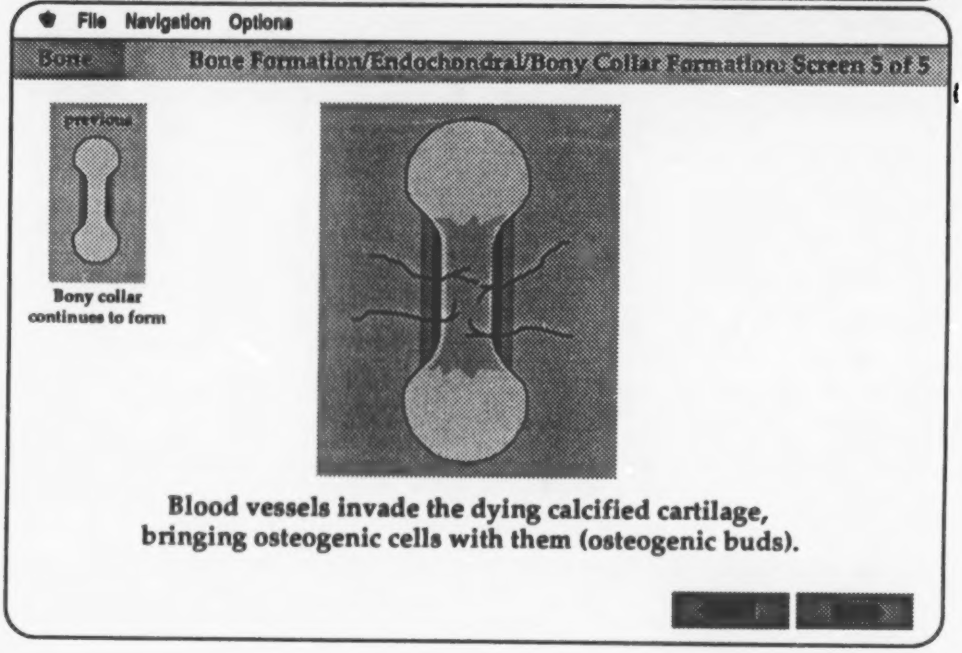
Informing the user of the the size and content of the various components in a hypermedia database, as well as where he is in these components, and consequently,


File
Navigation
Options
Bone
previous
Bony Collar

Bone Formation/Endochondral/Bony Collar Formation: Screen 4 of 5

Perichondrium forms bony collar

The perichondrium continues to become osteogenic rather than chondrogenic, forming a bony collar around the shaft of the model.


File
Navigation
Options
Bone
previous

Bone Formation/Endochondral/Bony Collar Formation: Screen 5 of 5

Bony collar continues to form

Blood vessels invade the dying calcified cartilage, bringing osteogenic cells with them (osteogenic buds).

Figure 3.

where he is in the overall database improves his chances of using the database effectively.

Links

There are two types of links in a hypermedia learning environment: unstructured and structured. In many ways, the power of hypermedia has been the promise of allowing the user to freely link different pieces of information and media, limited only by boundaries of the environment and the function of the program. When *designing educational material, it is absolutely essential for the author to anticipate and create specific informational links.*

Unstructured Links. The ability to access any part of the lesson environment, either directly or indirectly via a series of menu selections, is an example of how the user can make links or associations in a free, unstructured manner. For example, a student in the bone lesson might desire access to information in the connective tissue lesson. Because all lessons in a major subject area are accessible via pull down menus, the user may utilize a pull down menu to make this connective tissue link, resulting in an immediate routing to that lesson. Using the menu options in the lesson, the user then navigates to a specific point in the lesson.

Another example of the ability to freely associate is in the use of the glossary. The glossary is always available to the user via a pull down menu. To find a term in the glossary, one simply selects the glossary from a pull down menu and is linked directly to the glossary. In the glossary one can roam freely among the entries or look up specific words. In both of these instances, the lesson environment allows the user to jump freely from lesson to lesson, lesson to glossary, making connections between specific pieces of information that are not necessarily anticipated by the authors.

Structured Links. As stated previously, it is important for the software developer to anticipate and create links. There are various types of links but with one common ability: they provide multiple and explicitly related connections among different pieces of information.

A link is often a doorway to a more detailed explanation of a subject: material review, greater depth, definitions and so on (see Figure 2). Other times, the link is merely another angle on the main source of information, or just a parallel source of information. Examples might include an illustration which accompanies an image, an inset, or a different image which provides another view of the same object. Sometimes the link is optional, as in the case of a hot button, giving the user an opportunity to explore a topic in greater depth; other times the link is automatic, as in the case of simultaneously presenting a digitized image on one screen and a simplified illustration of the image on the other.

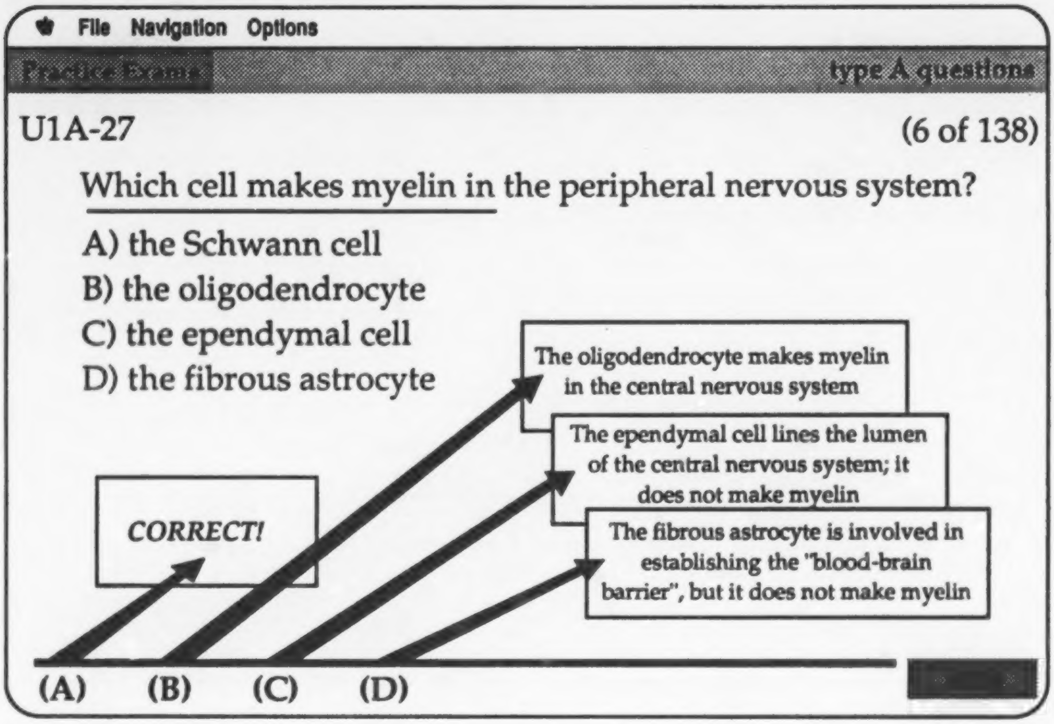
These structured links have three characteristics in common: first, the associations are specific; second, the associations are anticipated by the author; and third, the associations, optional or automatic, are built into the lesson at a specific place and only available at those specific locations (unlike pull down links to other lessons and the glossary).

The value of these structured links is that they are *anticipated* by the software developer who uses his or her expertise and experience to anticipate where users may have problems or may need more or different types of information on a topic. By anticipating and providing specific hyperlinks, a hypermedia environment is created that has elements of freeform hypermedia, but also provides a structure that has specific limits and teaching goals. Access to information is not left completely up to the whim or free association of the user. Thus, it is the responsibility of the developer of an educational hypermedia environment to provide a learning structure that gives *guidance* to the learning process; in other words, one which actually teaches rather than simply provides a free floating collection of related yet disjointed points of information. Anticipating and creating specific information links is one way guidance can be provided.

Distillation of content into succinct units of information

In order to accommodate the various strategies that learners use to navigate through lessons, at the minimum, the basic conventions for moving forward and then tracing the same path backward should be available at any given time. Traditional hypermedia environments have often placed the burden on the user to trace that "backward path" through the material in order to review a specific concept or point of information. However, lessons can be designed to extract content already covered and refer to it in such a way that the need for this review path is minimized. One advantage in using this technique, for the less sophisticated learner for example, is that it focuses attention on the salient points of the instruction, separating them from all accompanying detail. Moreover, a context in which to present new information is established.

The basic premise behind this technique is to provide users with frequent references to information previously displayed so that they may use it as a foundation for learning newer material. These references are composed of segments of instruction which have been distilled and assembled into succinct, discrete units of information. The units may contain text or graphics or a combination of both. They contain little of the detail that the initial learning point contained; rather, they focus on the general concept presented (see Figure 3).



U1A-27 (6 of 138)

Which cell makes myelin in the peripheral nervous system?

A) the Schwann cell
B) the oligodendrocyte
C) the ependymal cell
D) the fibrous astrocyte

(A) CORRECT!

(B) The oligodendrocyte makes myelin in the central nervous system

(C) The ependymal cell lines the lumen of the central nervous system; it does not make myelin

(D) The fibrous astrocyte is involved in establishing the "blood-brain barrier", but it does not make myelin

Figure 4.

Their purpose is to provide the learner with a sense of the prerequisite knowledge necessary to master the present concept, and to help transfer that knowledge to the present situation. These units also provide a navigational context because they always represent information that has previously been explained and clarified. Displaying these references directly on a portion of the user's screen gives the user access to this information without having to go back and find the place where it was initially discussed.

While use of this technique may obviate the need for the user to frequently "go back and review," imposing this structure does not *prevent* the user from tracing a "backward path" through the lesson if desired. In fact, users who need to go back and review the details and nuances of previously presented information should do so. At the same time, the technique enables those who are ready to move ahead to do so, taking with them a reminder and understanding of the knowledge required for further learning.

Quizzes

Providing options from which the user may directly access quizzes is a common hypermedia design technique, lending itself well to building in the flexibility that many learners will likely use. Others may prefer to take quizzes in the context of the logical progression of instruction. Whether a quiz is chosen by the user or presented as a result of an assessment of the user's performance to date, several techniques can be used to structure the quiz experience. As quizzes are multipurpose by nature -- they may be used as self-assessment tools, in preparation for a formal evaluation, as teaching tools, or just for fun -- the challenge to the designer is to anticipate these needs and integrate them into the quiz environment.

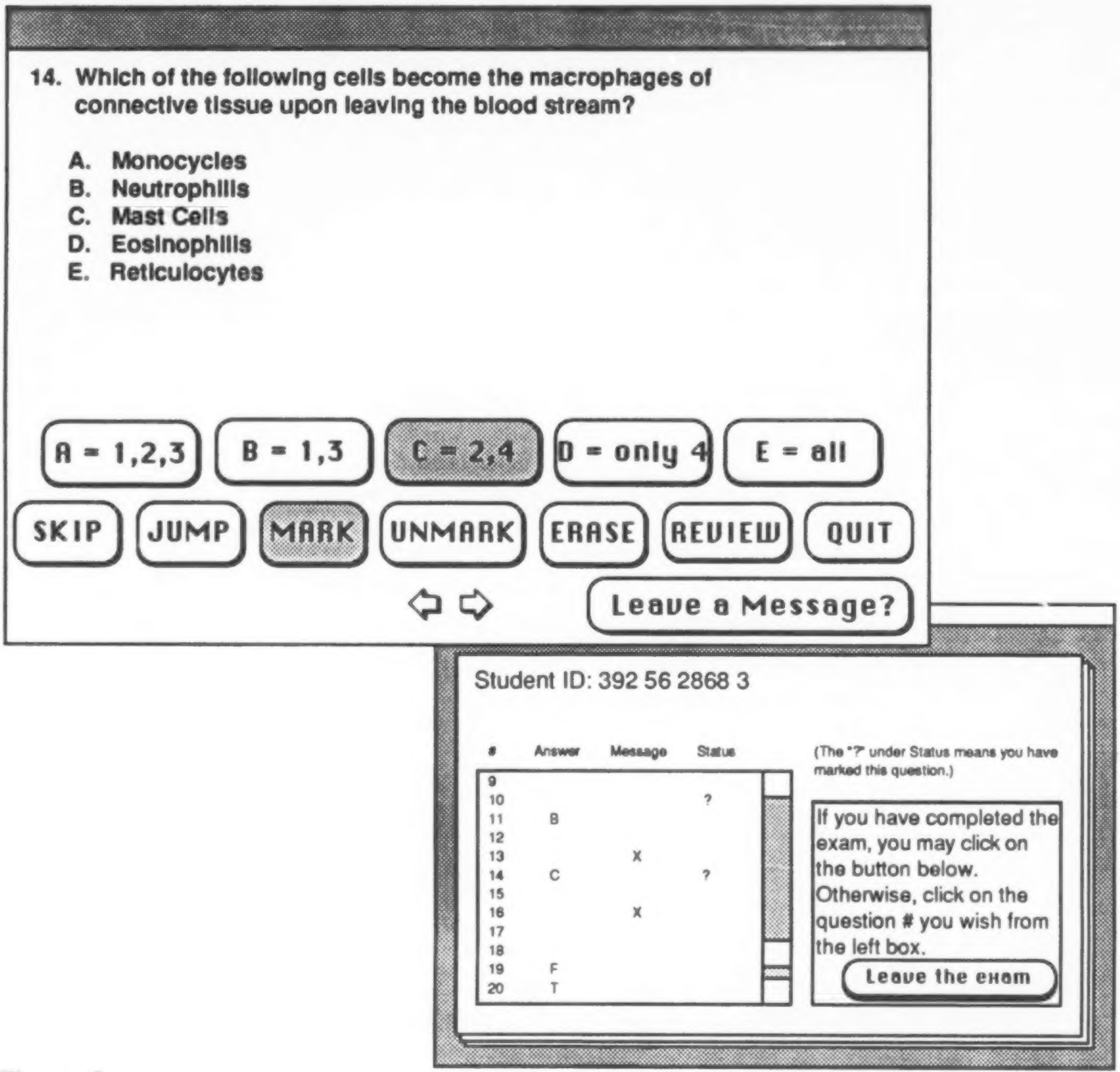
A random presentation of the questions decreases the likelihood that the quiz simply becomes an exercise in memorization. An *option* to see a cumulative score will satisfy those students who are curious without burdening those who would rather not know their scores. Options to restart the quiz at any time will benefit those students who are using the quiz as a teaching tool or who are performing especially poorly but now want to assess themselves "for real." A "quit at anytime" option is essential to those using the quiz in a teaching tool mode.

But the *key* to designing a multipurpose quiz lies in the provision of instructive, informational feedback, *which the user may or may not choose to see*. Good feedback not only tells the user whether the answer given is correct or incorrect, it provides teaching points (see Figure 4). Carefully constructed feedback may focus the learner on another dimension of the problem or suggest a different strategy in approaching the problem; it should avoid revealing the answer.

For example, a student wishing to use the quiz as a pretest to assess his or her weak areas may want to work through a representative number of questions and receive a meaningful score reflecting his or her grasp of the content matter. Another student who wants the benefit of the teaching information included in the feedback may go through the quiz and select all the incorrect answers to a given question simply to find out *why* they are incorrect. A combination of these two modes may be achieved if the quiz is structured in such a way that the score reflects only the user's initial response to the question. Hence, the learner would not be penalized for applying a hypermedia approach to seeking instruction, or, in other words, accessing the feedback to all possible responses. Instead, that flexibility is inherent in the design of the quiz.

Examination Component

Designing a computer-based examination component can be difficult in a hypermedia environment due to the rigidity often inherent in the nature of giving/taking exams. While it is important to carefully design the exam so that only the information specified by the exam author is accessible by the user, a good computer-based exam must offer the user the same navigational and contextual flexibility that a paper-based exam allows. That is, the user must be able to work through the exam in any order desired, skip and later return to specific questions, change and modify answers, place "tick marks" next to difficult questions for later review, make notes on a scratch pad if desired and review progress to date. A key element to making a user comfortable with taking a computer-based exam is to give the user full control when it comes to committing to one answer or another.



14. Which of the following cells become the macrophages of connective tissue upon leaving the blood stream?

A. Monocycles
B. Neutrophills
C. Mast Cells
D. Eosinophills
E. Reticulocytes

Student ID: 392 56 2868 3

#	Answer	Message	Status
9			
10			?
11	B		
12			
13		X	
14	C		?
15			
16		X	
17			
18			
19	F		
20	T		

(The "?" under Status means you have marked this question.)

If you have completed the exam, you may click on the button below. Otherwise, click on the question # you wish from the left box.

Figure 5.

An effective technique in designing an examination is the provision of a review or progress screen (see Figure 5). This screen displays the question numbers corresponding to each exam question along with the user's answers (or a blank, if the question has not yet been answered), and indications regarding the status of a given question. For example, if a question has been "tick marked" by the student for later review or if the student recorded some notes on the electronic scratch pad for that question, those actions are reflected on the review screen. The review screen is continuously updated throughout the exam so the student may assess his/her progress in an ongoing manner. Further, by linking each question number on the review screen to the corresponding question in the exam, the student may use the review screen to jump directly to any question in the exam.

While it is important to provide an option for the user to exit the exam at will, it is also prudent to ensure that the user is satisfied that s/he has completed the exam in a thorough manner. To achieve this, a mechanism which automatically scans the student's progress can be invoked. This mechanism checks to see that all questions have indeed been answered and that no questions are still left "tick marked." If these two criteria are not satisfied, a message is displayed advising the user that an exit will be permitted only when all the questions are both answered and unmarked. The user is then automatically returned to the review screen to identify the specific questions that need to be re-visited.

Finally, a computer-based multiple choice exam has the benefit of being able to tabulate a score immediately. An *option* to see the examination score will satisfy the curious yet spare those who may not need/want to see that information right away.

Conclusion

This paper has outlined various techniques for establishing structure within a hypermedia environment; that is, providing users various routes, both guided and unguided, through large bodies of electronic information. These techniques range from anticipating links for student paths through the program to providing directories of images and modules with suggested, but not mandated, paths indicated. This dual approach allows users to move freely from screen to screen or module to module charting their own courses, while also suggesting preferred pathways through the content. Thus, users at varying levels of sophistication and expertise can choose the learning modality most suited to their needs. Individuals new to the content may choose the suggested path, while others using the material for review or self-assessment may opt to approach the material in a more unstructured fashion. Therefore, unlike pure hypermedia environments, learners at all levels will be able to adapt the software to meet their own dynamic needs, exercising even more control over their own educational experiences.

Finally, while this paper discusses a program designed specifically for use with medical students, the underlying philosophy is applicable to educational software programs for all levels and types of learners. By applying the techniques outlined above, educators will provide effective learning experiences for a greater range of students. Moreover, these students can become self-directed learners employing a range of problem solving and information acquisition skills in their quest for further knowledge and understanding.

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TEACHERS AS HYPERCARD AUTHORS: WHAT CAN THEY DO?

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Abstract

"Teachers will never develop their own computer programs". HyperCard has proven this statement false. Data is presented on secondary teachers' success as novice computer program authors. Their work is compared to experienced authors' programs and is evaluated for potential users. The impact of the authoring process on the authors is assessed. The resulting Instructional Technology Guidebook is discussed.

Introduction

Several years ago, technology training planning committees in many school districts, decided not to even consider authoring their own software nor to teach the teachers how to do it"Teachers will never develop their own computer programs", it was said"It's too difficult and time consuming."

Today, HyperCard programs developed by Jefferson County Public School District (JCPS) high school teachers are available for use and as models for other Macintosh using teachers. While these programs may not be professional quality, they prove the point that teachers can develop useful CAI programs with a limited amount of training and development time. In addition, they demonstrate that in the authoring process teachers learn, not only about the operation of computers and software programs, but also more about their curriculum and how to teach it using technology.

This paper addresses questions about what teachers can do given limited experience with an authoring tool, the usefulness of such learning to teachers, and the usefulness of the resulting stacks to others.

CAI Authoring Tools

The authoring process is one of the most challenging tasks in producing computer assisted instructional programs. It involves turning flowcharts, control algorithms, format sheets and other design documentation into computer code that will make the program operate correctly in the delivery system (Reeves, 1986).

The alternative means for writing computer code are to use a programming language (BASIC, Pascal, C), an authoring language (PILOT, Coursewriter, TUTOR), or an authoring system (QUEST, TICCIT). A programming language is a set of commands for producing prescribed outcomes understood by both the programmer and the computer (Hannafin & Peck, 1988). Although teachers can learn to use BASIC for relatively simple applications, a professional programmer is required for development of complex programs.

An authoring system is a software package designed to lead the user through the process of creating CAI instruction without requiring programming (Hannafin & Peck, 1988). These systems are often restricted in flexibility although easier for the non-programmer teacher to use. Authoring languages offer the best compromise between the flexibility of programming languages and the ease of use of authoring systems. HyperCard offers the advantages of both an authoring system and an authoring language.

HyperCard has been described as a CAI authoring tool, an information organizer, a four dimensional blank slate, a software erector set, and a hypermedia tool kit (Tsuk, 1989). The key to HyperCard authoring is HyperTalk, "a marvelously simple programming language" built into HyperCard (Sculley, 1988). With HyperTalk, virtually anyone can become a software author and produce professional looking Macintosh applications.

Three uses of HyperCard can be of value to teachers (Echols & Rossett, 1989; Allen, Dodge & Saba, 1989). Use as a data base program allows linking of data elements in fields on various cards. As a hyper media vehicle, it presents and handles nonlinear text associations, graphics, music, speech, sound, animation, video disc and other external devices thereby eliminating the need for devices and products in some formats and coordinating the use of others.

As an authoring tool, HyperCard has simple capabilities for the nonprogrammer to complex possibilities that challenge experienced programmers. Prototypes and storyboards can be prepared directly on computer to cut duplication of work in other formats. The authoring capabilities seem to have the greatest potential since Hyper. Talk is easy to learn and yields professional looking results. In addition, teachers master some of the programming skills necessary to use digital technologies.

HyperCard also has disadvantages which include limited audio capability, black/gray and white only, reduced fidelity and resolution in displays when compared to motion pictures and slides. But remedies are around the corner.

Teachers as CAI Authors

Teachers have expertise they can combine with a versatile authoring tool. They know the curriculum and are familiar with effective instructional approaches for their students. Also, many teachers long for more exciting and effective ways to present their instruction. With JCPS's establishment of Macintosh writing labs in high schools, all secondary teachers now have access to HyperCard's capabilities.

An obvious question is, why would teachers want to author HyperCard stacks? Those who have done it know that the authoring process can satisfy some deep motivational needs and desires as well as practical issues of software availability. Other reasons include these.

1. "Designing and scripting your own stacks is neither so hard as to be intimidating nor so time consuming as to be prohibitive if programming isn't your primary occupation" (Shafer 1988, pp. 2).
2. If you want something done right, you have to do it yourself. Your stack can be the way you want it to be rather than someone else's idea.
3. You understand better how to use something you've designed.
4. The creative process itself is rewarding and enjoyable.
5. In designing a stack to solve a problem, you will gain some insight into the nature of the problem itself and thus become a better problem solver.
6. Authoring gives a positive boost to your self esteem and fosters confidence in ability to master complex skills.
7. It develops understanding and insight into the use and importance of computers and software in education (Heimler, Cunningham, Nevard, 1987).

Authoring stacks can also cause teachers to rethink how they present their curriculum to students. Computer based materials may be more meaningful and motivating. They can present information in a consistent manner. Teachers can more closely monitor student learning. The teacher will discover a new role as facilitator of learning.

HyperCard Program Development

During 1989-90, 240 secondary teachers received 12 hours of training on HyperCard as part of a larger inservice program on instructional use of Macintosh. Training was conducted for two groups of 120 each by the JCPS Computer Education Support (CES) teachers. The University of Louisville School of Education provided the opportunity to receive university credit for the "New Kid Graduates" training. It was hoped that many teachers would apply the hours to a 30 credit post-masters program with emphasis on instructional technology.

In order to qualify for university credit, teachers had to complete two projects; one had to use HyperCard. The HyperCard project was intended to pull together HyperCard techniques, instructional design and content area curriculum.

The 12 clock hour HyperCard training consisted of these topics: creating a simple stack with appropriate instructional and screen design; creating cards with background and with text in various size, font, styles; fields, buttons, simple scripting and linking; copying and creating graphics; scanned images; sound. On-site follow up support by CES teachers allowed those who were interested to receive further 1 on 1 assistance in completing their projects.

From Phase I training (January to October), 30 HyperCard stacks were completed. From Phase II (May to December), 70 were completed. The stacks were related to the high school curriculum or to use of the Macintosh. Topics ranged from "The Nine Planets" to "Network Management", from "The Orient Express" to "HyperCard Sounds and Visual Effects Tutorial". Three of the stacks were for teacher use only, 66 for student use and 26 for use by both. Two were created for students by students under teacher supervision. Five were excluded for poor quality. About an equal number of stacks were developed for science, math and language as well as use of Macintosh and its programs.

The stacks were analyzed to identify the components of HyperCard and authoring concepts used. The average stack contained 16 cards and ranged in size from 8 to 135 cards. Most were intended to deliver information about a topic, were not interactive and did not assess learning. The next largest group was tutorials that provided information, examples, checked learning and included a post test. Some others provided drill and some were response shells that had students respond to questions about novels read and print the responses as a paper. One IAV driver stack was submitted. Some stacks were designed to be used concurrently with a data base, a spreadsheet or CD-ROM. Some had follow up assignments.

Most stacks included a title card, menu, introduction or overview. Few specifically stated the objective to be accomplished. Most had accurate and appropriately organized information. Many branched from the menu but some were linear. Some branched within the stack and some branched for feedback. Extensive use was made of buttons, scrolling fields, printing fields, varied text size/fonts/style, clip art, scanned graphics, screen captures and draw tools. Of the stacks that used graphics, the most frequent number was one though the one may have been repeated on several cards. Some stacks used as many as 38 different graphics. Many stacks had no way to orient the user to the sequence of the present card, but the most often used technique was a card label. Most stacks appropriately arranged the text and card display.

Table 1. Analysis of HyperCard Stacks

1. Number of HyperCard Stacks: Phase I = 30, Phase II = 70, Total = 100

2. Curriculum areas:

Science	Math	Language	Social Studies	Computer	Other
17	20	22	3	34	4

3. Average number of different navigation button messages in stacks: Phase I = 5; Phase II = 4

4. Other features used in stacks

	Scroll field	Animation	Print field	Talk	Background design	Button menu	Response buttons
I	6	2	8	3	2	1	1
II	24	10	18	10	18	35	11

5. Average number of varied text size/font/style per stack: Phase I = 3.5; Phase II = 3.8

6. Number of stacks using branching

	Branch at menu	Branch in stack	Branch at feedback	Linear
I	5	2	2	2
II	39	9	2	16

7. Type of graphics used in stacks

	Scanned	Drawn	Icon	Clip art	Modified clip	Pattern	Screen capture
I	7	6	3	17	2	1	1
II	11	13	15	38	3	4	15

8. Number of graphics used in stack

	0	1	2	3	4	5	6-38
I	5	17	5	2	1	0	0
II	7	6	5	7	6	2	22

9. Types of instructional tactics used

	Mnemonics	Interactive task	Interactive questions	WP, DB, CD	Posttest	Print response	Literary quotation	Follow Up assignment
I	1	16	1	2	4	3	1	0
II	0	20	4	8	16	6	2	9

10. Appropriate text and display

	Yes	No	Comment
I	25	5	crowded, needs variety, straight text, messy,
II	57	13	all capitals

11. Information accuracy and organization

	Yes	No	Comment
I	26	4	information with no cues or examples
II	69	1	

12. Has a way to orient to card sequence

	Card label	Card number	Nothing
I	18	1	12
II	26	9	32

13. Average number of cards: Phase I = 17; Phase II = 16

14. Type of program

	Tutorial	Discovery	Information	Drill	IAV	Response shell
I	10	1	15	1	0	3
II	26	0	37	3	1	5

15. Types of cards designed

	Title	Credit	Direction	Menu	Objectives	Overview
I	27	13	5	12	7	10
II	60	15	25	33	7	23

Some used straight text that gave a crowded and messy appearance. Some typed text in all capitals.

The novice authors, by and large, created programs that were amazingly good for the amount of training given. The stacks from Phase II were even better than those from Phase I. This may have resulted from trainers who now had more expertise with HyperCard and could demonstrate and follow up with more examples and techniques.

During about the same time period in 1989-90, two consecutive university courses focusing on HyperCard were offered. A core group of teachers took both additional courses. In the second course the experienced authors were joined by a group with no previous training on HyperCard. The focus was instructional design and screen design, scripting, development of visual, audiovisual and video disc stacks. During the second course, there was a great deal of collaboration and critiquing of stacks among all students. The resulting 46 stacks from the two courses were also analyzed. There seemed to be little difference among the two groups in the second course in terms of quality of stacks and applications of HyperCard techniques.

The stacks by experienced authors were typically more complex than those by novice authors. Experienced authors' stacks showed greater application of instructional design in the way they were designed and executed. More sophistication was evident in screen design and lay out. Creativity seemed to be a larger factor in their stacks. But with additional instruction, experience and particularly time, the novice authors could reasonably expect to produce programs, on a par with those of the experienced authors. As with most things, experience shows.

Evaluation of HyperCard Stacks

Developing CAI programs is just an interesting, though time consuming hobby unless those programs are useful and the development process adds to the author's growth as a teacher. To assess the usefulness of the new stacks, the CES teachers reviewed and rated them. Their purpose was to select stacks that could be refined and included in an Instructional Technology Guidebook for distribution to all high schools.

Of 146 stacks, 95 were selected for inclusion in the Guidebook. Most needed some degree of revision and some needed extensive revision.

The stacks were edited and annotated by a group of 15 teachers who were identified as excellent HyperCard users. Most of them had participated not only in the initial training but also in the two courses. They used a checklist to examine and revise each program to meet the criteria.

Figure 1. HyperCard Checklist

STACK
- ☐ has been compacted
- ☐ includes an overview/introduction
- ☐ includes an objective
- ☐ includes directions as needed
- ☐ has a menu allowing nonlinear access
- ☐ clear focus and logical progression of program
- ☐ performance measure of learning
- ☐ content, spelling, grammar correct

CARDS
- ☐ includes a title card
- ☐ each card has navigation options
- ☐ adequate white space
- ☐ one idea per card
- ☐ appropriate graphics are used
- ☐ text is in fields
- ☐ text size, style, and font is appropriate

FIELDS
- ☐ appropriate font options
- ☐ text locked when not to be changed
- ☐ wide margins for text
- ☐ scrolling field rather than card full of text
- ☐ one idea per field

BUTTONS
- ☐ use same locations for same buttons
- ☐ uniform styles
- ☐ work as intended
- ☐ purpose clearly indicated
- ☐ no extraneous buttons

BACKGROUNDS
- ☐ appropriately used

The most frequent revisions and additions were ways to check responses, more graphics and examples, breaking up dense text loads, using more interesting instructional strategies, tighter focus on the program objective, increased interactivity, printing out test results and a comment card.

Interviews with the teachers revealed some authoring tips they learned through the experience. If a script doesn't work at one level, it may at another level. Use a conservative approach and change only one variable at a time. It may affect something somewhere else in the script. Compact the disk and save information frequently. Have a back up disk in case of disaster. A faster machine makes development easier, but keep in mind the end user machine. Think about whether to use the Macintosh as a PC or to run the stack through the network server. There is a time variable. The PC gives consistent rate but the server may slow down when dealing with several requests. For some stacks, this may make a difference.

The work of many teachers has resulted in the Instructional Technology Guidebook. It provides a wealth of material for use by teachers and students.

Included are diskette copies of the refined HyperCard stacks as well as examples of other software tools that were part of the New Kid Graduates training. The software programs are presented as part of a larger instructional design. Each is described by topic; expectation; content areas/thinking skills; intended use by user and by environment; enabling activities for teacher and student; hands on activities; follow up/feedback activity; evaluation of student learning; application type.

Impact of Authoring

To assess the impact of the authoring activity on stack developers, a questionnaire was given to the 15 teachers described above. While probably not representative of the total group of authors, their reactions provide some insight into the value of their involvement.

They indicated that during the New Kid training they had not learned much new information about computers but did learn a lot about HyperCard and computer authoring. They learned about instructional design and screen design as well as suitable instructional approaches for use in computer programs. All indicated that the process of working with HyperCard has added to their professional growth and most felt it has also added to expertise with their curriculum. These are teachers who have mastered a new area that they will continue to use for the benefit of students and other teachers.

Conclusions

Teachers can become HyperCard authors and still have time to be teachers. They can develop stacks to teach their curriculum As a group, they can devise stacks that will cover many important areas that are taught year after year. Expertise with computer based curriculum development tools empowers teachers to use technology more appropriately and successfully.

Specific conclusions are as follows.

1. Given a minimal amount of training (12 hours) and development time (40 hours), secondary teachers who are novice HyperCard users can develop simple CAI programs suitable for use in the content areas they teach or for training other teachers on use of the technology.
2. Given more extensive instruction and/or follow up support, teachers can develop fairly sophisticated stacks using visual, audio-visual and interactive video formats.
3. The differences between novice developer stacks and experienced developer stacks lie primarily in the use of instructional design, screen design and layout and in creativity. These are largely factors of training, experience and time. The creativity is shown in novel ways to present ideas visually. The impact of print versus graphic visual presentations is vividly demonstrated in a stack.
4. Teacher developed stacks are useful, appropriate and suitable for use by teachers and students. Those programs can be used by other teachers for instructional purposes and as models for additional HyperCard stacks.
5. Teacher authors indicate that they experience professional growth as they combine a CAI authoring tool, instructional design and their curriculum area.
6. Teachers can share this tool with their students who use it to develop their own programs. When students present learnings in an instructional format, they learn them better. Student authoring of HyperCard stacks can offer divergent and creative paths to improving writing skills, developing thinking processes and self expression in different modalities.

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STRUCTURING KNOWLEDGE FOR HYPERTEXT-TYPE INFORMATION ACCESS

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Abstract

Research at United States Army Construction Engineering Research Laboratory (USA-CERL) has contributed some new information to the issue of locus-of-control in Computer-based Training (CBT). Architectural and engineering designers indicated that they favored options which permitted them to explore the training materials without computer intervention. The users also indicated that they preferred on-the-job support as opposed to a purely training session. Hyper. Text-type environments are often suggested to provide resource support that may be controlled by the user. User control offers flexibility and adaptability to those with a wide range of learning styles, objectives, and entry knowledge, as was found in our test sample. However, control of the learning environment by the student can be confusing and frustrating, especially for new trainees. Structuring the knowledge with awareness of user modes and tailoring the interface to correspond to the structure is an approach to the problem. Our prototype system employs this methodology.

Background

Research on computer-based instruction for computer-aided design (CAD) software began at USA-CERL in 1985. Corps of Engineers architects, engineers, and drafting personnel tested interactive embedded instruction for the AutoCAD software package. Test subjects completed the computer-based course of study and were tested for knowledge of the CAD system. Our findings were reported to ADCIS (Shaw, 1988). We then conducted follow-up interviews to investigate some of our hypotheses concerning the research results (Shaw and Golish, 1989).

The interviews with test subjects brought up new issues that should be considered by those who train adult professionals. Factors of individual variation in objectives, learning style, and resource needs suggested additional instructional system requirements. Questionnaires and interviews also disclosed that some features of our earlier computer-based training (CBT) were inappropriate for the intended audience. Some of the problems leading to new system design stemmed from traditional CBT approaches and some from the needs of the target audience.

Problems

Traditional CBT. The tutorial displayed reminders to practice the exercises and gave feedback if expected errors were made. These features were either disliked or were considered unnecessary by many of the users. Eighty-six percent agreed with the questionnaire item "I usually knew when I did things wrong in the lessons." Twenty-eight percent indicated that the reminders annoyed them. They remarked that they would practice if they liked and that they usually could see if they were correct or not as they worked with a drawing.

Users did indicate that most of them preferred learning about CAD from interacting with a computer rather than studying it from a book. However there was agreement that they knew what they needed to learn and appreciated help in reaching answers to specific questions. The index and the freedom to explore the command menus were very popular features.

In general, when the user controlled the learning it was the most effective. These learners preferred not to be subjected to many of the most common CBT design features. The reasons for this are rooted in the differences between adult professionals and the school children who have been the test subjects for most traditional CBT.

Audience Needs. We discovered that the best CAD users were required to use CAD intensively in their work and were "discovery" oriented in their learning style. These users tended to have specific objectives in mind and tested their own ideas as they worked. They often skipped around in the lessons by means of the index and tended to learn the parts of the system that were most closely related to their own work. Those concerned with file transfer noticed "clean" databases and the size of the file, while those concerned with accuracy picked up the information about numeric input. Users might not notice features which they did not meet in their work.

In many of the interview situations, skills and techniques were observed that were not part of the lesson objectives. Users would demonstrate iterative features and programming routines that had not been specifically taught. Setting lesson objectives for these sophisticated students was a questionable process. Outcomes, particularly student-specific ones (Eisner, 1985), should be a main concern in training for adult professionals.

It was common to hear that learners had reached a point in the lessons at which they felt prepared to apply their learning to a work project and had left the training for a period of time. Many times they returned to the lessons after completing a production design. They would explain that they understood more after working with a "real" problem. They would then seek out areas of study in which they realized they were weak. Apparently their metacognitive capacities developed from on-the-job experience and could be trusted to guide their learning. As has been observed in other current research (Steinberg, 1989), these users developed learning strategies as they became more aware of CAD concepts.

Another problem to be considered is that different types of representations are more instructive for people of different cognitive learning styles. This was particularly observed in this audience of architects, engineers, and drafting personnel. While some learn through abstractions (words), others may profit more through imagery (pictures), activity (practice), or concretizing (examples) (Mayer, 1983). At times it may require more than one type of representation to illuminate a concept and that may depend upon the concept itself. "The test ...(of concept specifications)... should focus on the specific functions of a particular concept" (Engelmann, 1969).

Some of the test subjects expressed the need for having the lessons present while they worked on a design." Ideas flow better with facts at our fingertips-fewer interruptions for look-ups, and fewer detours down blind alleys" (Penzais, 1989). Others indicated that the lessons took too much time from their jobs and that it meant more when they could apply the information as they worked. They preferred to seek specific topics to study as the need arose, rather than set aside a period of time for training. This finding prompted us to consider Computer-Based Training (CBT) with a higher degree of user control than we had previously used. The Hyper. Text approach was an obvious possibility. The problem was to design a concurrent instructional system which would provide for user differences in knowledge and objectives.

System Requirements

Some of the requirements of the new system came about as a response to the tests and interviews. Flexibility in mode of use was specifically aimed at the adult professional audience. Other requirements grew from our increased study of information processing. User control of the environment presents some new problems in our high-tech world. It is relatively simple to arrange a small body of information and provide computer access to it, but it becomes a very difficult task to do the same thing for a large, complex, and possibly interrelated body of information. We are told that soon all documents that are valuable enough to keep will be available electronically, which is an overwhelming idea. Levels of abstraction and methods of classification become extremely important issues.

The first requirement was that the training should run concurrently with a drawing and remain in view while the drawing is active. On most large workstation screens, it might occupy a part of the same screen or a second monitor. Even on a PC workstation, the user could swap back and forth between the training and the design file with a single keypress. Design files especially prepared for each lesson would be developed. They would contain drawing elements that directly correspond to the practice exercises. Most of the exercises could be practiced in any design file. The system might then be used with a lesson drawing, a blank drawing file or a "working drawing" in progress.

Different modes of use that should be accommodated might be:

1. Overview
2. Sequential
3. Discovery/browsing
4. Look-up

"Overview" mode is a common user mode. A manager might wish to scan the content to get the basic concept information, but not examine procedures or examples. Learners often wish to preview or review information. Some students desire a sequential pattern when the subject area is new to them. As they become more familiar with the topic, they often develop their own objectives and wish to explore specific lines of thought in a "discovery" mode. "Sequential" learners would probably use the prepared examples and practice exercises. Those who are more discovery oriented might use a CAD drawing that they are working on, or might design exercises for themselves. In "look-up" mode, the user would be in pursuit of specific procedures or details while working in a drawing file.

Several different types of relationships between information must be established:

1. An implied linear topic sequence
2. Capability of cross referencing in a Hyper. Text-like mode
3. Several different possible organizational patterns for accessing the information, among them priority of usage, category of operation, continuum of procedure, and alphabetical
4. Different types of information (pictorial, example, practice, explanations) related to the topics when appropriate
5. Direct links to related topics
6. Provision for the system to link to the growing body of documentation and applications needed in the future

The linear sequence makes starting points and next steps obvious to learners. It solves the problem often found in documentation when there are several manuals included or where the information is alphabetically arranged. User observations and assumed entry knowledge determine the most appropriate sequence. For example, in our introductory MicroStation instruction DELETE ELEMENT is placed before PLACE ELEMENT because users were frustrated when they drew unsatisfactory elements and did not know how to erase them. Also, PLACE FENCE should be taught before CREATE CELL because a fence must be placed around the cell elements before the complex element

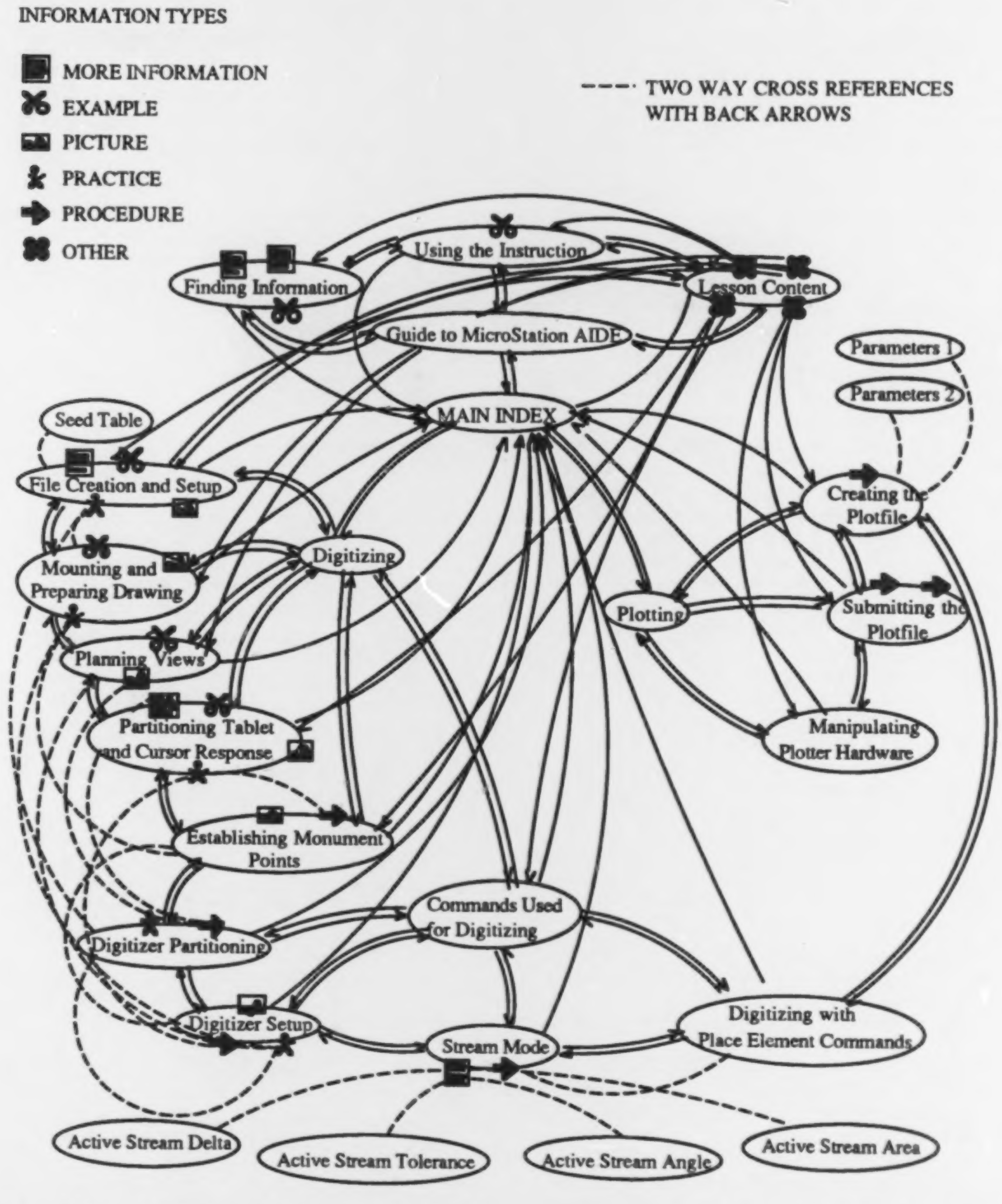

INFORMATION TYPES
MORE INFORMATION
EXAMPLE
PICTURE
PRACTICE
PROCEDURE
OTHER
TWO WAY CROSS REFERENCES WITH BACK ARROWS
Using the Instruction
Finding Information
Lesson Content
Guide to MicroStation AIDE
Parameters 1
Parameters 2
Seed Table
MAIN INDEX
File Creation and Setup
Creating the Plotfile
Digitizing
Mounting and Preparing Drawing
Plotting
Submitting the Plotfile
Planning Views
Partitioning Tablet and Cursor Response
Manipulating Plotter Hardware
Establishing Monument Points
Commands Used for Digitizing
Digitizer Partitioning
Digitizing with Place Element Commands
Digitizer Setup
Stream Mode
Active Stream Delta
Active Stream Tolerance
Active Stream Angle
Active Stream Area

Figure 1. Knowledge Structure Diagram. *All information screens provide a return to the MAIN INDEX. Those arrows have been omitted for the sake of clarity. Cross references always offer a return to the point of reference.*

may be created. However, all users will not use the sequential order if they are permitted to do otherwise and cross references should be provided to help them fill in information gaps if that is needed. This is one of the greatest powers that computer-based systems have over books. In a book, there is an implied sequence, but usually no provision for filling in skipped information other than using the index. Hyper-text approaches make such references easy.

Images of buildings might be presented geographically, historically, by architect, by view, or by function. Each method of arrangement offers new information and suits a different purpose (Wurman, 1989). Topics may be related, but not dependent upon each other. They should be provided with direct links. Alphabetical command referencing, available in many on-line help programs, is efficient when the command name is known. Otherwise, it may be likened to searching for an unknown name in the phone book when only the address is known.

The user interface for the system also has several requirements:

1. Be intuitive and require no additional instruction
2. Present complete information in each view without scrolling
3. Have some constraint upon the size of information chunks that the user must digest at one time
4. Return to the previous location at all times
5. Related knowledge clusters be associated with no more than four keypresses if possible
6. Clearly labeled access to related information and an obvious return provided to the original reference point after cross referencing
7. Different usage modes be obvious to the user
8. A system map which permits users to chart their progress and access other parts directly
9. Provide user-programmable reference links

Scrolling screens, even when they scroll both down and up, are distracting and hard to assimilate. If additional information is needed, a keypress should show a different page and its relationship to the first should be labeled. Return to the previous screen should be an option from all screens. From cross references, a simple back-arrow must be provided, since cross referencing is often not meant to shift attention from the user's main objective. The scrolling screen constraint serves to keep a focus in concept presentations; however, the size of larger knowledge blocks must also be controlled and the relationships between them clearly defined. Methods such as annotated tables of contents and monitoring user activities should aim at quick access to the desired information. Prioritizing among the available options may be possible through intelligent programming approaches.

It is important that users be able to track their performance through the computer information. If a map is available that shows the current location in the knowledge structure and what selections have been viewed, users can orient themselves. If a user decides to change modes, for example from sequential to discovery, it should be easy to make the change.

Mapping Information Content

In order to visualize the structure of the system, a knowledge cluster diagram is used. For each content node there are entry and exit arrows to other, more general, more specific, or parallel nodes. These are clustered according to category of operation. Cross references are provided to procedures or terms which may be needed to use or understand a given explanation if a student has followed other than the implied sequence. These are indicated by dotted lines. Different types of information are represented by icons overlapping the topic to which they are related. Arrows will not be drawn from these icons in the interest of simplicity.

Figure 1. is a graphic representation of the links between information clusters. It shows the structure of a small portion of the knowledge offered in a prototype concurrent embedded support system for the Intergraph MicroStation CAD system. This segment covers electronic / hardcopy media transfer, specifically trace digitizing and plotting. The selection is relatively simple, offering five levels of generalization at the most. It is a small part of the entire system.

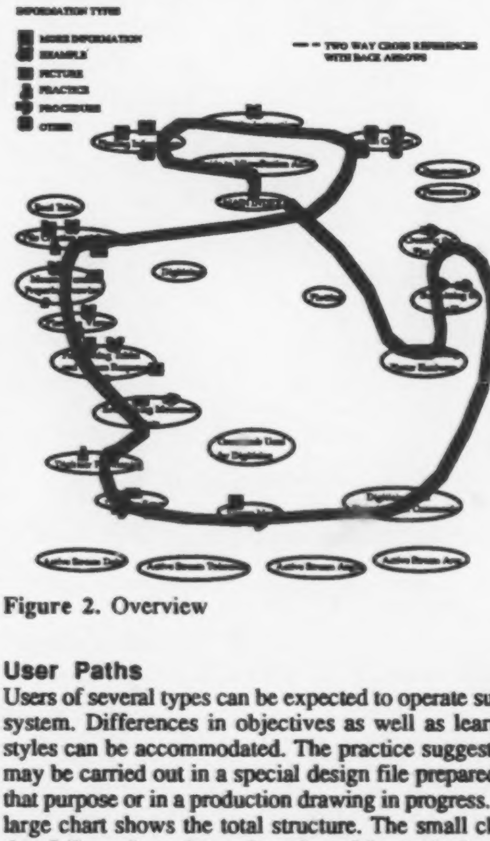


Figure 2. Overview

User Paths

Users of several types can be expected to operate such a system. Differences in objectives as well as learning styles can be accommodated. The practice suggestions may be carried out in a special design file prepared for that purpose or in a production drawing in progress. The large chart shows the total structure. The small charts that follow show the paths selected by typical users. Refer to the large chart to read the text. The user in Figure 2. has elected to review just the main topics in the structure. It is probable that the information needed is rather superficial. Perhaps this is a manager or someone trying to obtain an overview. In this case, there may be no design file for practice, since the practice exercises are not viewed. This is a quick way to become familiar with the general coverage of the subject. The way to use this mode is to select the

NEXT TOPIC button. LAST TOPIC would show the same thing in reverse order. See Figure 7. for the interface.

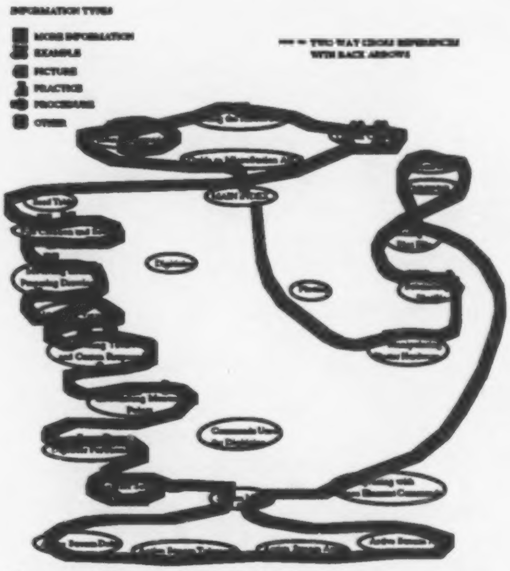

INFORMATION TYPES
MORE INFORMATION
EXAMPLE
PICTURE
PRACTICE
PROCEDURES
OTHER
TWO WAY CROSS REFERENCES WITH BACK ARROWS
MAIN INDEX

Figure 3. Sequential Path

The user in Figure 3. has progressed sequentially through all of the information screens. The user is possibly a structured learner who doesn't want to miss anything. Probably this user would be working from the special design file and would likely try the practice exercises. NEXT CARD and LAST CARD would be employed to work through the instruction in this mode. See Figure 7.

The user in Figure 4. has used the indices to reach selected topics and pursue some of them in detail. Cross references have been used and some practice exercises have been viewed. The user may be using either the special design file or a production drawing. This type of usage indicates a motivated user, probably discovery oriented. Most professional designers and draftsmen exhibit this type of path. At the beginning they may be structured learners, but they quickly become more discovery oriented.

The user in Figure 5. has moved to the annotated table of contents to locate the particular information needed and has gone directly to the stream mode parameters. This type of path would be typical of the experienced user who needs specific support for his production. This user is

Many on-line help systems provide a browse mode which is helpful for the discovery learner. Such behavior on the part of the user assumes some familiarity with the subject. The major differences in our system are the overview and sequential paths that are clearly indicated. Look-up mode is also available in many systems for the user who knows what he wants to find. However, a great many systems do not allow users to view the help while carrying out the instruction their own projects. Many times a user must copy the information from a detailed help screen in order to keep it in mind.

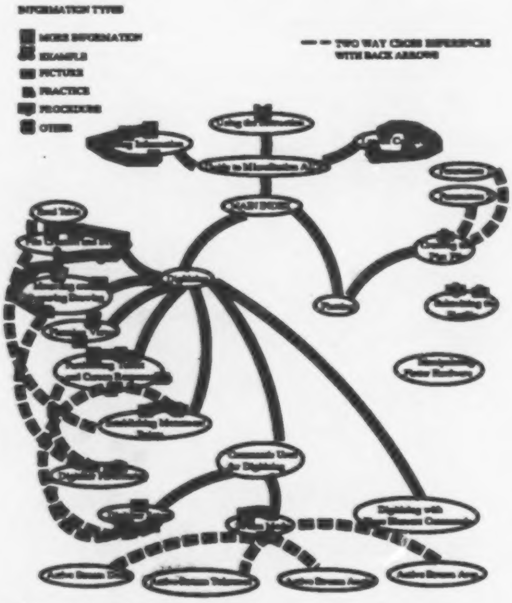

INFORMATION TYPES
MORE INFORMATION
EXAMPLE
PICTURE
PRACTICE
PROCEDURES
OTHER
TWO WAY CROSS REFERENCES WITH BACK ARROWS
MAIN INDEX

Figure 4. Discovery Path

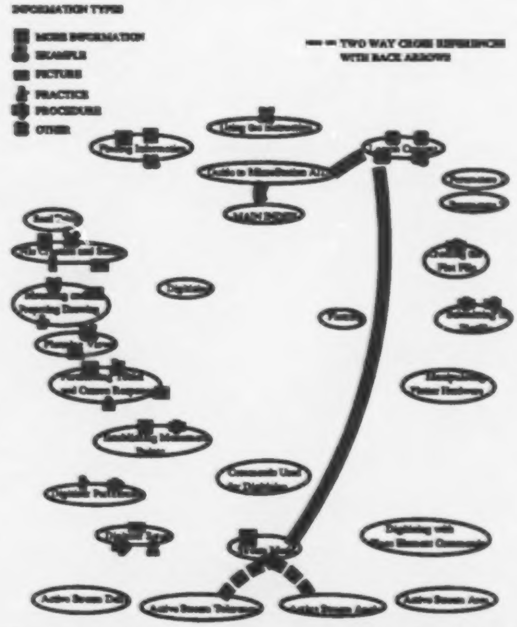

INFORMATION TYPES
MORE INFORMATION
EXAMPLE
PICTURE
PRACTICE
PROCEDURES
OTHER
TWO WAY CROSS REFERENCES WITH BACK ARROWS
MAIN INDEX

Figure 5. Look-up Mode—the one who would make the most use of alphabetical organization.

The Interface

The interface must be constructed with the knowledge structure in mind. Finding the correct content and type of information must be intuitive and efficient. We used a "FileCard" metaphor. Cards are arranged in boxes which represent menus. You may click the mouse or digitizer on the tab to read the card. See Figure 6.

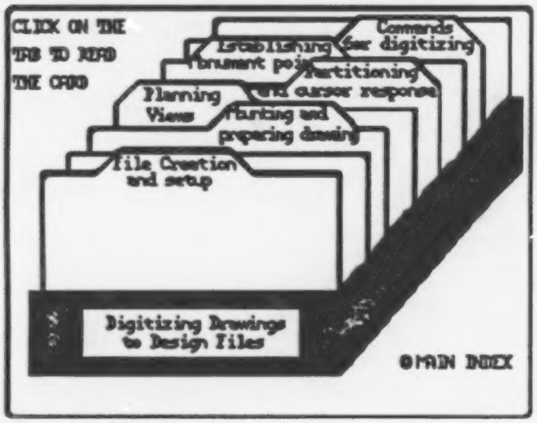

CLICK ON THE
TAB TO READ
THE CARD
Commands for digitizing
Establishing Monument points
Partitioning and cursor response
Planning Views
Mounting and preparing drawing
File Creation and setup
Digitizing Drawings to Design Files
MAIN INDEX

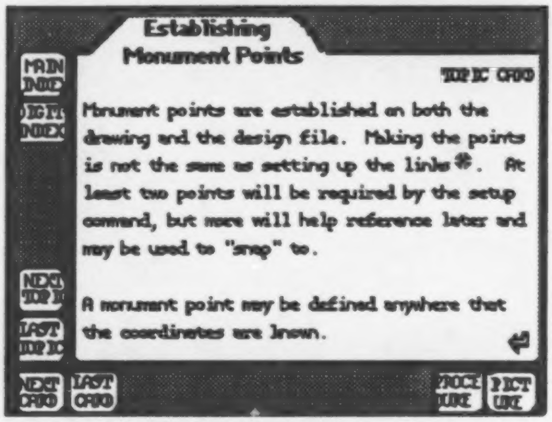
Figure 6. File Box

A learner may move through all of the cards by selecting the NEXT CARD button or backwards sequentially by selecting LAST CARD. If only the general topics are desired, NEXT TOPIC or LAST TOPIC will present that type of overview. Cross referencing is also possible. Clicking the mouse or digitizer on the symbol, ❖, jumps directly to the information about DIGITIZER SETUP. The return arrow provides a return to another cross-reference page. See Figure 7.

Buttons on the bottom right-hand edge of the card relate to the same topic. Index buttons are at the top left edge and sequential buttons are at the lower left-hand corner. NEXT TOPIC and LAST TOPIC cards appear on the TOPIC CARD for each section. "Design the set of alternative methods for a task so that the rule for selecting each alternative is clear to the user and easy to apply" (Card, Moran, and Newell, 1983).

The card size limits the amount of information in each chunk. If more space is required, the nature of the relationship must be defined.

There are no requirements on type or number of information cards for a topic, however the space for buttons tends to limit the treatment to those with highest priority. If more buttons seem to be necessary, a sub-topic should be considered. In this way, relationships are clarified and boundaries are set. Also, it is always possible to add new information when the structure is expanded.


MAIN INDEX
DIGIT INDEX
NEXT TOPIC
LAST TOPIC
NEXT CARD
LAST CARD
PROCEDURE
PICTURE

Establishing
Monument Points

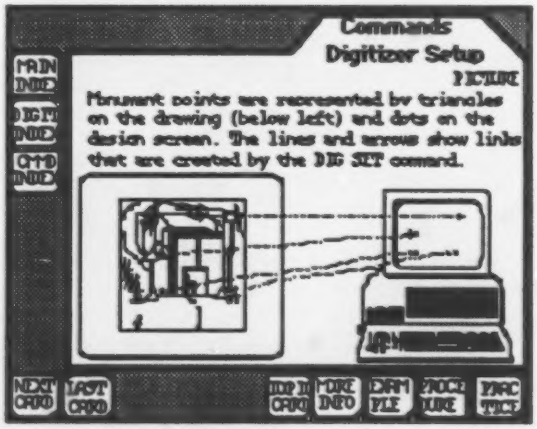
TOPIC CARD

Monument points are established on both the drawing and the design file. Making the points is not the same as setting up the links❖. At least two points will be required by the setup command, but more will help reference later and may be used to "snap" to.

A monument point may be defined anywhere that the coordinates are known. ↵

Figure 7. Topic with cross references

TOPIC CARDS present general explanations. MORE INFORMATION cards usually go into more detail about the concept. PROCEDURE and PRACTICE cards are used when needed. Practice cards suggest exercises in the prepared drawing file. Pictures and examples as shown in Figures 8 and 9 are essential for some learners and are generally included. Other types of cards may be employed for special purposes, such as NOTES cards to accompany the table of contents.


MAIN INDEX
DIGIT INDEX
CMND INDEX
NEXT CARD
LAST CARD
TOPIC CARD
MORE INFO
EXAMPLE
PROCEDURE
PRACTICE

Commands
Digitizer Setup

PICTURE

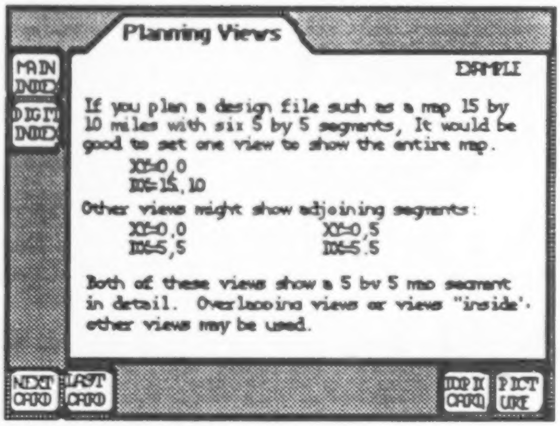
Monument points are represented by triangles on the drawing (below left) and dots on the design screen. The lines and arrows show links that are created by the DIG SET command.

Figure 8. Concept Illustration

System Consistency

Experience over the last five years proves that frequent changes can be expected in both hardware platforms and software systems.

Users may use many computers, based upon availability, application, and specific work assignment. Portability between environments is a requirement for text files, drawing files, and databases. Training and support systems should also be portable and as consistent as possible.



Planning Views

EXAMPLE

If you plan a design file such as a map 15 by 10 miles with six 5 by 5 segments, It would be good to set one view to show the entire map.

XY=0,0
DX=15,10

Other views might show adjoining segments:

XY=0,0   XY=0,5
DX=5,5   DX=5.5

Both of these views show a 5 by 5 map segment in detail. Overlapping views or views "inside'. other views may be used.

Figure 9. Example

Users should not encounter frustration when they change machines. While certain applications packages and hardware may offer additional powers, these should be viewed as enhancements, not learning problems. The concurrent support system designed at USA-CERL is able to accommodate this need. With this capability, instruction for one computer system could be referenced from a different computer. At times, this might be the most efficient use of resources.

Conclusion

User controlled, HyperText-type support systems offer the flexibility and adaptability that adult professionals require. Carefully designing the knowledge structure and the computer interface with user modes in mind is one way to provide freedom, as well as a control mechanism to the user. Consistency between different platforms of the same software system should be a general objective in CBT.

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Selected Formal Papers from the

Special Interest Group for Interactive Video and Audio (SIGIVA)

PROTOTYPING INTERACTIVE MULTIMEDIA EXHIBITS FOR MUSEUMS: A CASE STUDY

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Abstract

This case study describes the application of interactive multimedia technology and rapid prototyping methodology to the development of exhibits for a new aquarium-museum under construction at Scripps Institution of Oceanography. Developed by graduate students in educational technology at San Diego State University, the prototype exhibits reflect diverse paradigms for informal learning and content ranging from shark physiology to ocean climate patterns. The prototypes will be used to demonstrate the potential of interactive multimedia exhibits and to solicit funds for development of full-scale versions. Rapid prototyping enables exhibit curators and designers to represent proposed designs in forms that are tangible enough to permit evaluation by sponsors and administrators as well as by representative visitors.

Introduction

What is a museum exhibit? A plaque with text and graphics? Silently staring animal specimens? Artifacts encased in glass? For centuries, museums have preserved and displayed real objects. Now computers, video, and interactive multimedia have expanded the options for visitors to explore and interpret museum collections. New media-based paradigms such as hypermedia and hypertext offer conceptual pathways that can make museum experiences more meaningful.

There are two reasons that museums have been slow to adopt interactive multimedia. Few museum specialists are aware of the rich and dynamic communication potential of interactive multimedia technologies or how they can be applied to make museum information more accessible and useful to the public. Most museum specialists do not have enough experience with these new media to visualize complex computer-based designs from paper-based specifications.

The second reason that interactive media are not yet prevalent in museums has to do with money. Securing funding can be particularly difficult with interactive multimedia exhibits--unless the potential sponsor can see an actual example of the proposed project. Therefore, one of the first challenges facing would-be developers of multimedia exhibitry is to represent proposed designs in forms that are tangible enough to permit evaluation by sponsors and administrators as well as by museum visitors.

This case study examines how HyperCard™-based interactive video systems can be used to create prototypes appropriate for presentation to a variety of audiences. It also describes how graduate students in educational technology can contribute to the development of interactive multimedia exhibits and how rapid prototyping can serve the needs of clients as well as student designers.

Origins of the Project

In the Spring of 1989, the authors entered into a series of discussions with staff from Scripps Institution of Oceanography Aquarium-Museum at the University of California San Diego. Those discussions lead to the creation of four prototype interactive videodisc exhibits for the museum portion of Scripps' new aquarium-museum facility. The prototypes were researched, written, and produced by graduate students from the Department of Educational Technology at San Diego State University in collaboration with content specialists from Scripps. For descriptions of the SDSU educational technology curriculum on interactive multimedia, see Allen and Erickson (1986) and Allen, Dodge, and Saba (1990).

Scripps Institution of Oceanography (SIO) Aquarium-Museum in La Jolla, California, hosts nearly 400,000 visitors each year. Presently, the Aquarium-Museum is in the planning and fund raising stages for an aquarium-museum facility to replace their aging, 40-year old aquarium. The new 32,000 square-foot facility will enhance the aquarium's ability to meet its major mission: interpreting research done at Scripps Institution of Oceanography for the public.

Visitor research conducted in 1989, showed that the Aquarium-Museum serves three audiences:

- Organized groups, mostly classes of school children, who come to the Aquarium-Museum for a one-hour guided tour, conducted by a volunteer interpreter. The interpreters tend to be retired individuals who are trained in the basics of marine science by the Aquarium-Museum education staff.
- Local families who visit the Aquarium-Museum on the weekends as an entertaining and somewhat educational experience for adults and children to share. Overwhelmingly, these small groups come to see the variety of fishes.
- Out-of-town visitors who have heard of SIO from friends or family. This group also comes primarily for entertainment, but like the family groups, many express considerable interests in aquariums, in fishes, and in ocean-related hobbies.

The Scripps staff was interested in developing interactive exhibit prototypes for two reasons. First, they wanted to explore new ways to help the public to interpret oceanographic research. Second, they sought inexpensive prototypes that could be shown to potential sponsors and agencies who might fund the new facility, due to open in 1992. Since this was the Aquarium-Museum's first experience with technology-based exhibits, the staff was open to development of several different prototypes--each exemplifying a different mode of interaction or a different approach to visitor exploration. For the graduate students in "Educational Technology 653: Interactive Video Instruction," the four prototypes represented an opportunity for "hands-on" development of interactive multimedia programs intended for informal learning environments.

Project Goals

A major goal of the Scripps prototypes was to demonstrate how interactive multimedia exhibits could be used to help visitors acquire information at their own pace and integrate it with other museum experiences. Several factors were considered during early planning stages; among them were Scripps' concerns regarding:

- specific subject matter related to the Aquarium-Museum's mission;
- traffic patterns and visitor flow through the museum;
- visitor interactions limited to two or three minutes at each interactive exhibit.

Audience analysis is critical to the success of any museum exhibit. The design of interactive multimedia exhibits for a museum environment must take into account the typical Scripps visitor who is likely to be:

- a first-time user;
- relatively uninformed;
- of various ages, nationalities, and educational levels;
- reading at a level about 7th grade equivalent;
- anxious about an unfamiliar medium;
- spending less than a minute at each exhibit.

A second goal of the project was to show how interactive multimedia might be used to increase exhibit "holding power" which in the case of traditional exhibit technology is generally low. Clowes and Wolf (1980) reported that visitors at one museum spent only 17-23 seconds looking at dioramas. According to Van Rennes (1981), "in most museums, visitors spend only an average of 45 seconds at any one exhibit." Observations of visitor viewing patterns at Scripps indicate similar patterns: viewing times for current exhibits cluster at seven seconds and seventeen seconds.

Interactive multimedia exhibits rely on diverse paradigms for structuring information, ranging from architectural/spatial (Sircus, 1989) to taxonomic (Diamond, Bond, & Hirumi, 1989). Interactive multimedia posed a challenge for the museum's professionals who were unaccustomed to thinking in terms of diverse and simultaneous structures. On the other hand, it also challenged the students whose graduate training had emphasized mastery-oriented instructional design. Informal learning is intended to entertain, to inspire, to captivate and to raise curiosity without focusing on measurement of explicit learning outcomes.

Museum exhibits present unique requirements for the application of interactive multimedia technology. For example, one of the most difficult challenges is the appropriate usage of audio. Transient sound effects and short audio segments are acceptable, but long audio passages often interfere with the experiences of museum visitors who are not observing the videodisc exhibits. Several exhibits with significant amounts of audio can result in a tangled audio mess. To accommodate this constraint, three of the prototypes are primarily text-based. (The fourth is intended for use in a classroom where noise limitations are not a concern.)

To capture visitors' interests and curiosity without relying on audio, exhibit texts are written in an interpretive style. Interpretive writing strives to link new concepts and information to the visitor's prior experience and knowledge base. It uses simple descriptive language to suggest visual images. It also uses questions as a tool to stimulate visitor participation in the exhibit.

Rapid Prototyping

The graduate students used rapid prototyping methodology to develop working versions of the exhibits. Interactive multimedia programs integrate diverse communications modalities (ranging from speech and music, to photos and motion pictures, to text and diagrams) in complex and dynamic relationships. Hence, environments for developing and exercising interactive multimedia prototypes must be able to demonstrate how these modalities will be coordinated. Furthermore, the prototypes must communicate to decision-makers and representatives of the visiting public who may have a limited ability to visualize designs represented through means such as narrative descriptions, flowcharts, and storyboards.

Rapid prototyping—a term borrowed from software engineering--refers to ". . . system development methodology based on building and using a model of a system for designing, implementing, testing, and installing the system" (Lantz, cited in Tripp and Bichelmeyer, 1990, p. 35). Rapid prototyping requires a computer-based development environment that permits a modular approach to development and allows software to be edited and reshaped quickly. On the other hand, the development environment must be disciplined enough to permit logical definitions of the prototype and physical representations that are stable enough so that they can be exercised or tested.

Finally, there is the design process itself. Since exhibits are rarely expected to promote specific learning outcomes, it is more useful to think of them as part of informal learning environments rather than as devices for instruction or training. Systematic approaches to design in which exacting definitions of learning outcomes precede prototype construction may be less effective than more open and intuitive approaches in which exhibit designers refine their proposals for learning outcomes following direct experimentation.

As a paradigm for exhibit design by graduate students in educational technology, the potential advantages of rapid prototyping with *HyperCard™* are four-fold: (1) it permits student designers to explore alternative designs with relatively modest investment in programming; (2) it allows them to communicate the "look and feel" of a proposed product to reviewers and decision makers; (3) it encourages early formative evaluation with representative users; (4) it serves as guide to completion of a final version which may be developed and delivered through systems other than *HyperCard™* and by specialists other than designers. A special advantage of *HyperCard™* for rapid prototyping is that screen displays and user controls can be quickly and easily modified by designers who have little programming experience. The ease of modifying HyperCard™ prototypes makes detailed paper-and-pencil designs less important, perhaps changing the need for rigid approaches to design documentation.

Project Development

Several months before the course began, the authors laid groundwork for the project by conducting an informal analysis of Aquarium-Museum exhibit needs and by developing tentative formats and topics for the exhibits. Twenty-five graduate students, two professors of educational technology, the aquarium-museum director and the curator of education were the primary participants in this project. Others included subject-matter experts from Scripps, San Diego State University, and private research companies. The students were split into four working teams. Within these teams, individuals were designated as specialists: instructional designer, video producer, graphic artist, etc. Two students were designated as class managers, one specializing in the technology and the other as a subject-matter/museum specialist and liaison with Scripps.

The development budget was restricted to $2,400 of which $1,000 was allocated to mastering two copies of a 54,000-frame videodisc. Each team was allocated $50 for out-of-pocket expenses. Other resources were loaned or donated.

Individual teams researched the content of the exhibits; created the program specifications; and amassed resources and materials including photographic images from Scripps archives, video clips from a local television station, and original video shot for the project. Though planning and design documents specified complete exhibits, the prototypes were partial implementations: some on-screen buttons were "dummies," representing options for later development.

Description of Prototypes

The four prototypes are quite different from each other. They deal with different subject matter, uses different navigational systems, and employ different types of user interactions. Brief descriptions follow.

Exhibit 1: *The Fish Encyclopedia* uses an existing videodisc and is an example of a low-cost approach to exhibit development. Graduate student Tom Dwyer developed *PioneerScripter*, a HyperCard™-based authoring system for generating Level II videodisc control programs and downloading them into a Pioneer LD-V6000 player. *PioneerScripter* eliminates the need to program the LD-V6000 with a cumbersome key pad. With *PioneerScripter*, keying in a program can take less than an hour and downloading is nearly instantaneous. Control sequences can be saved on diskette for future use.

Twelve examples of underwater animal life were selected from the forty-five species featured on a commercial videodisc entitled "Fish and Invertebrates" (Pioneer Electronic Corporation, 1988). These examples were grouped in the following sections: "Fish Reproduction," "Fish Feeding," and "Fascinating Fish."

The Fish Encyclopedia was designed for viewing on a large screen built into a wall of the Museum-Aquarium. The control panel is to consist of five durable push buttons. Instructions on the screen guide the visitor through the steps. The exhibit can be used in three ways:

- The visitor can view the exhibit passively by watching a continuous introduction loop.
- The visitor can select a button which will take him/her to a set of four still photographs of fish.
- The visitor can select a third button to learn about any of the four fish.

Exhibit 2: *Exploring an Oceanographic Research Vessel* takes the viewer on video tours of research ships in the Scripps fleet (See Figures 1-7). This exhibit is intended to give visitor an impression of "life at sea" and of research aboard ship. Viewers select locations on a schematic of the ship: the engine room, living quarters, bridge, main lab, and after deck. In each location viewers observe the scientists and the crew members at work.

Scripps operates three basic types of research vessels. The vessel chosen for emphasis in the prototype was the *R/V New Horizon*, a typical surface ship. The prototype also includes brief introductions to *RV FLIP* (Floating Instrument Platform) and the *RV ORB* (Oceanographic Research Buoy).

Most of the footage for the prototype was shot documentary style. Live-action sequences and photographs were acquired from existing film documentaries. Footage shot aboard the *New Horizon* by team members was also incorporated into the program. People seen in the *New Horizon* video segments are actual ship personnel and team members.

Exhibit 3: *El Niño* explores an important and dramatic climatic phenomenon in which the flow of important ocean currents is reversed, resulting in odd and sometimes destructive weather patterns. Viewers follow a story line to learn about El Niño: its characteristics and range, how it effects ocean life, and how it appears in satellite photos.

Audio and text displays offer a general overview of the El Niño phenomenon. Visitors can use this information to predict the effects of El Niño on tuna populations and then manipulate ocean water temperature to test their predictions. Live video images (obtained from KFMB, a local commercial television station) show windstorms and coastal flooding caused by the 1983 El Niño. Animated satellite photography depicts current movement as seen from space (currents move in one direction during El Niño and in the opposite direction under normal conditions). These step-still satellite sequences of the 1983 El Niño were obtained from the California Space Institute, a research unit of the University of California, located on the Scripps campus. Additional remote sensing images indicate the locations of phytoplankton populations (a favorite food of the tuna) in order to illustrate some of the techniques fisherman use to locate large populations of tuna.

Exhibit 4: *Sharkey's Believe It or Not.* Unlike the other prototypes, *Sharkey's Believe It Or Not* was designed for sustained interaction as part of the aquarium-museum's classroom and interpreter-guided activities. Sharkey's defuses the sensationalism and myths surrounding sharks while using "gee-whiz" statements to capture the attention of young children and adults alike. Don Wilkie, Director of Scripps Aquarium-Museum, dissects a shark and shows viewers the shark's gut and other internal organs.

The program begins with a continuous attract loop in which "believe it or not" statements superimposed over footage of swimming sharks shown on a NTSC monitor. A menu of these "believe it or not" statements is displayed concurrently on a Macintosh screen and is available to the viewer at many key points in the program, thus encouraging pursuit of individual interests.

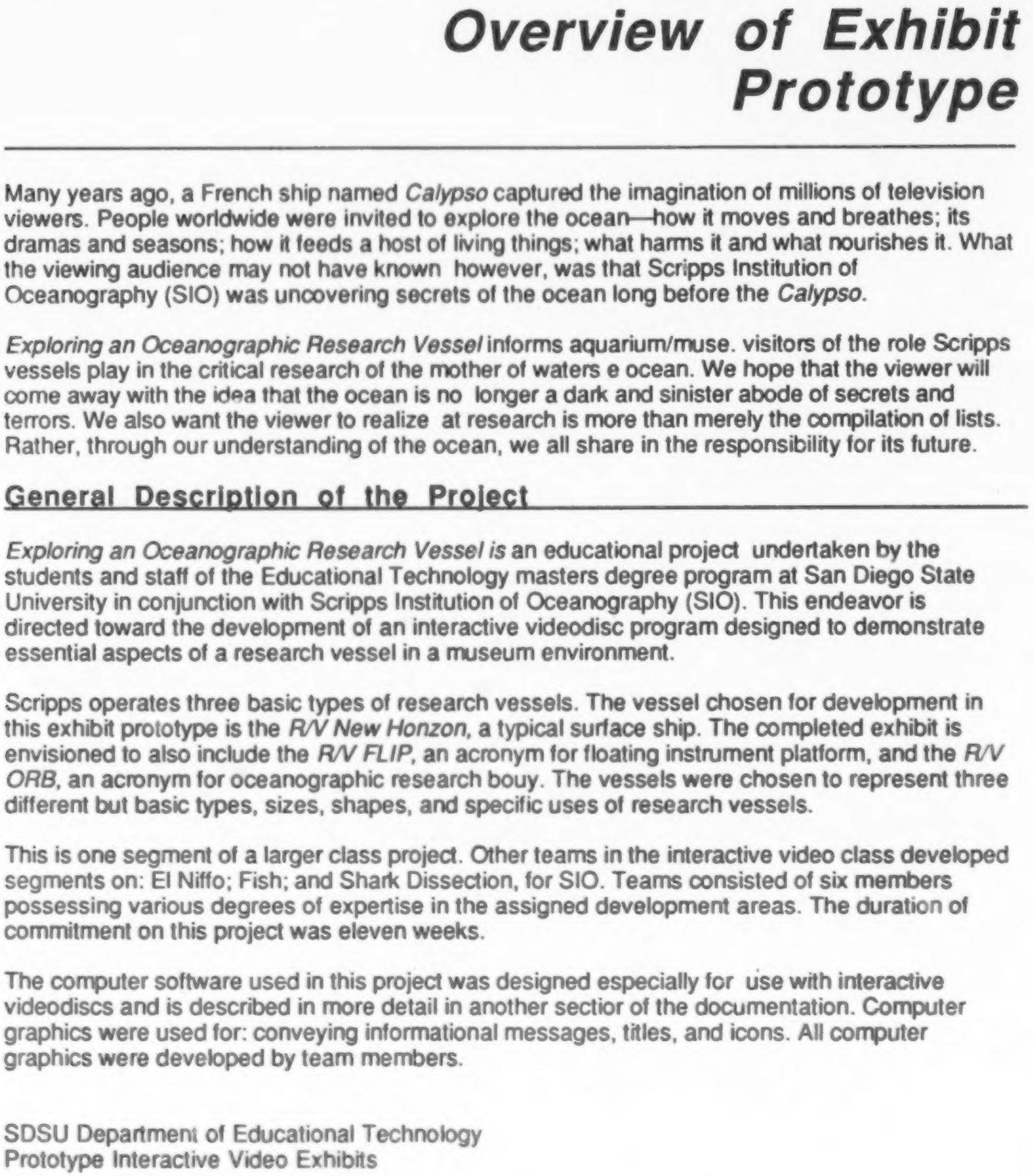
A submenu lists additional choices: "Jaws and Teeth," "Senses," "What Sharks Eat," and "Digestion." Viewers who choose to learn about what sharks eat, for example, see still frames of various sharks, each accompanied by a description of its eating habits. A video dissection of the shark's spiral valve (part of the digestive system with functions similar to the stomach/intestine in mammals) is also accessible. This portion of the prototype serves as an example of how multimedia technology can ease resource burdens by substituting electronic demonstrations for dissection.

Use of the Prototype for Planning and Fundraising

Shortly after the prototype exhibits were completed, Scripps Aquarium-Museum hired an exhibit curator, one with considerable interest in developing interactive multimedia-based exhibits. As of August 1990, the exhibit curator, working with a team that included one of the (former) graduate student project managers, completed conceptual plans for the 3,700 square foot. museum portion of the new facility. The new museum is built around the theme "Exploring The Blue Planet," and provides visitors with an overview of ocean sciences. The first exhibit area presents a history of oceanography, from the earliest "explorers" (ancient civilizations), to the start of modern oceanography in the early 1870's, to the present day. Visitors are invited to become oceanographers and explore the sea. Exhibits are based upon the theme of water itself (chemistry and movement), water with air (climate and weather), water with land (plate tectonics and sediments) and water with life (marine biology). A final series of exhibits invites visitors to consider the future of the Earth and emphasizes oceanographic research as it investigates global change. The exhibits emphasize exploration, hands-on experiences, and the scientific process.

Three interactive videodisc exhibits are currently planned for the new facility. Though Scripps staff was pleased with all four exhibit prototypes, only one will be included in the first phase of exhibit development and construction. That exhibit, *Exploring an Oceanographic Research Vessel* will be appear as part of an exhibit on the history of oceanography. This portion of the exhibit illustrates oceanographic instrumentation, including the vessels used for ocean exploration. Future plans call for additional interactive multimedia exhibits including several that are stand-alone interactive computer exhibits.

As a result of the project, the Aquarium-Museum has expanded its range of exhibit formats, planning more complex and more sophisticated exhibits that build on the student prototypes. By the Fall of 1990, Scripps will have produced a promotional videotape that explains the exhibits to potential sponsors. Narrated by former astronaut Wally Schirra, the tape will illustrate how the interactive exhibits work. Though the exhibits themselves are videodisc-based, a tape lends itself to more convenient demonstrations for interested parties. The viewer will see actual footage of aquarium visitors interacting with the prototype exhibits as well as additional examples of the types of video footage that will be incorporated into the final products.



Overview of Exhibit Prototype

Many years ago, a French ship named *Calypso* captured the imagination of millions of television viewers. People worldwide were invited to explore the ocean—how it moves and breathes; its dramas and seasons; how it feeds a host of living things; what harms it and what nourishes it. What the viewing audience may not have known however, was that Scripps Institution of Oceanography (SIO) was uncovering secrets of the ocean long before the *Calypso*.

Exploring an Oceanographic Research Vessel informs aquarium/muse. visitors of the role Scripps vessels play in the critical research of the mother of waters e ocean. We hope that the viewer will come away with the idea that the ocean is no longer a dark and sinister abode of secrets and terrors. We also want the viewer to realize at research is more than merely the compilation of lists. Rather, through our understanding of the ocean, we all share in the responsibility for its future.

General Description of the Project

Exploring an Oceanographic Research Vessel is an educational project undertaken by the students and staff of the Educational Technology masters degree program at San Diego State University in conjunction with Scripps Institution of Oceanography (SIO). This endeavor is directed toward the development of an interactive videodisc program designed to demonstrate essential aspects of a research vessel in a museum environment.

Scripps operates three basic types of research vessels. The vessel chosen for development in this exhibit prototype is the *R/V New Honzon,* a typical surface ship. The completed exhibit is envisioned to also include the *R/V FLIP*, an acronym for floating instrument platform, and the *R/V ORB*, an acronym for oceanographic research bouy. The vessels were chosen to represent three different but basic types, sizes, shapes, and specific uses of research vessels.

This is one segment of a larger class project. Other teams in the interactive video class developed segments on: El Niffo; Fish; and Shark Dissection, for SIO. Teams consisted of six members possessing various degrees of expertise in the assigned development areas. The duration of commitment on this project was eleven weeks.

The computer software used in this project was designed especially for use with interactive videodiscs and is described in more detail in another sectior of the documentation. Computer graphics were used for: conveying informational messages, titles, and icons. All computer graphics were developed by team members.

SDSU Department of Educational Technology
Prototype Interactive Video Exhibits

Figure 1. Excerpt from narrative portion of design documentation developed for *Exploring an Oceanographic Research Vessel.*

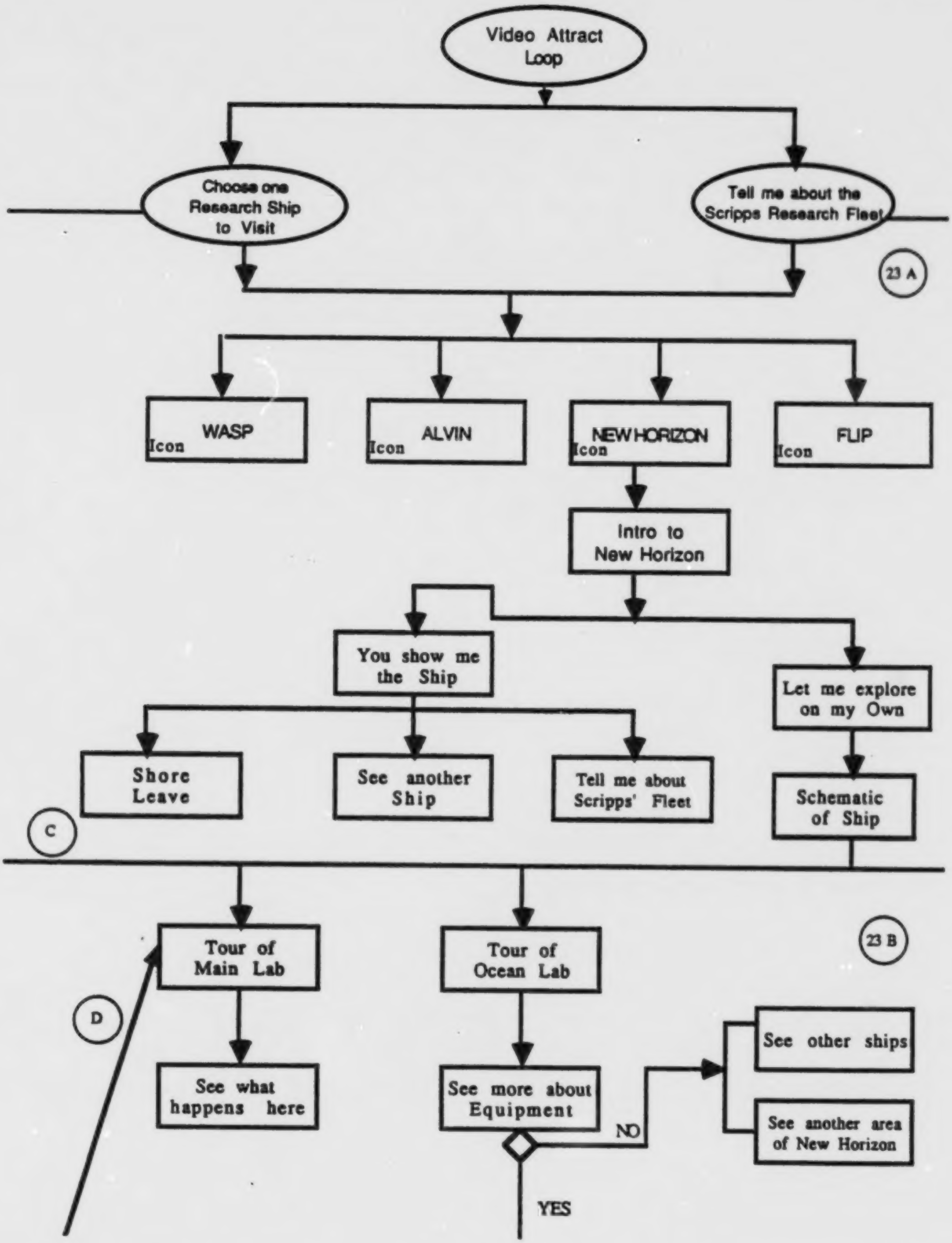
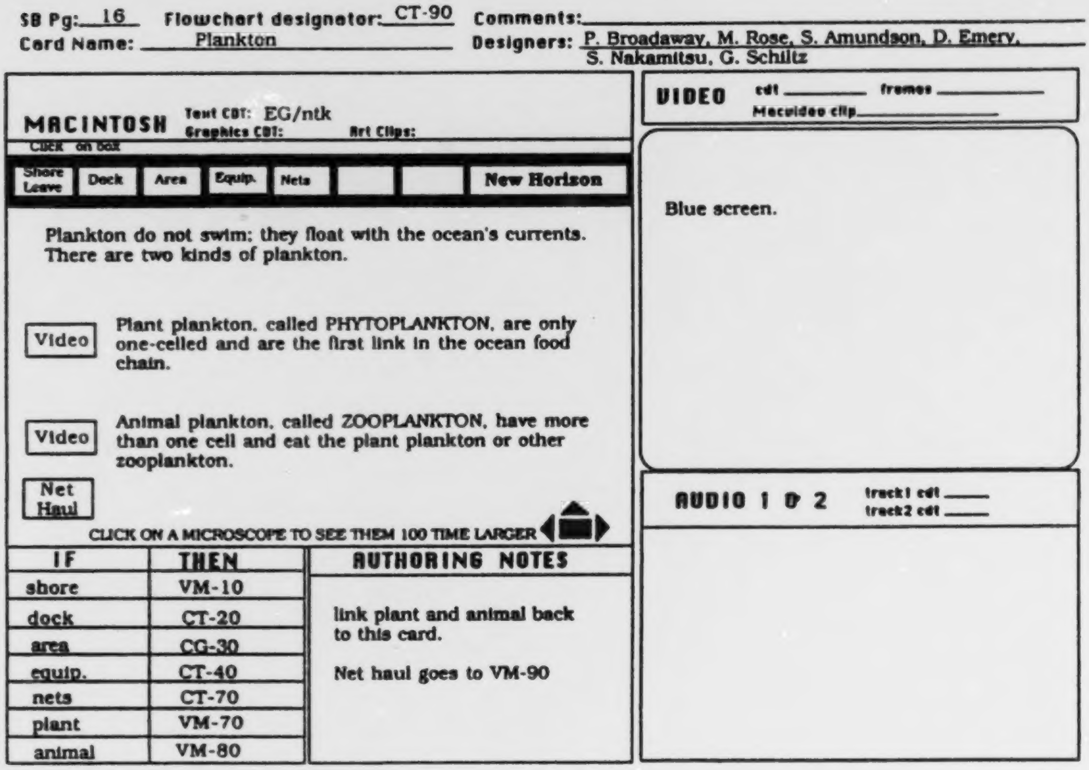

Video Attract Loop
Choose one Research Ship to Visit
Tell me about the Scripps Research Fleet
23 A
WASP
Icon
ALVIN
Icon
NEW HORIZON
Icon
FLIP
Icon
Intro to New Horizon
You show me the Ship
Let me explore on my Own
Shore Leave
See another Ship
Tell me about Scripps' Fleet
Schematic of Ship
C
Tour of Main Lab
Tour of Ocean Lab
23 B
D
See what happens here
See more about Equipment
See other ships
See another area of New Horizon
NO
YES

Figure 2. Portion of a block diagram for *Exploring an Oceanographic Research Vessel*. Diagram shows interrelationship between major program components.



MACINTOSH
Click on box
Shore Leave
Dock
Area
Equip.
Nets
New Horizon
Video
Video
Net Haul
VIDEO
AUDIO 1 & 2
AUTHORING NOTES

SB Pg: 16 Flowchart designator: CT-90 Comments:

Card Name: Plankton Designers: P. Broadaway, M. Rose, S. Amundson, D. Emery, S. Nakamitsu, G. Schiltz

Text CDT: EG/ntk

Graphics CDT:

Art Clips:

cdt

frames

Macvideo clip

Plankton do not swim; they float with the ocean's currents. There are two kinds of plankton.

Plant plankton, called PHYTOPLANKTON, are only one-celled and are the first link in the ocean food chain.

Animal plankton, called ZOOPLANKTON, have more than one cell and eat the plant plankton or other zooplankton.

CLICK ON A MICROSCOPE TO SEE THEM 100 TIME LARGER

Blue screen.

track1 cdt

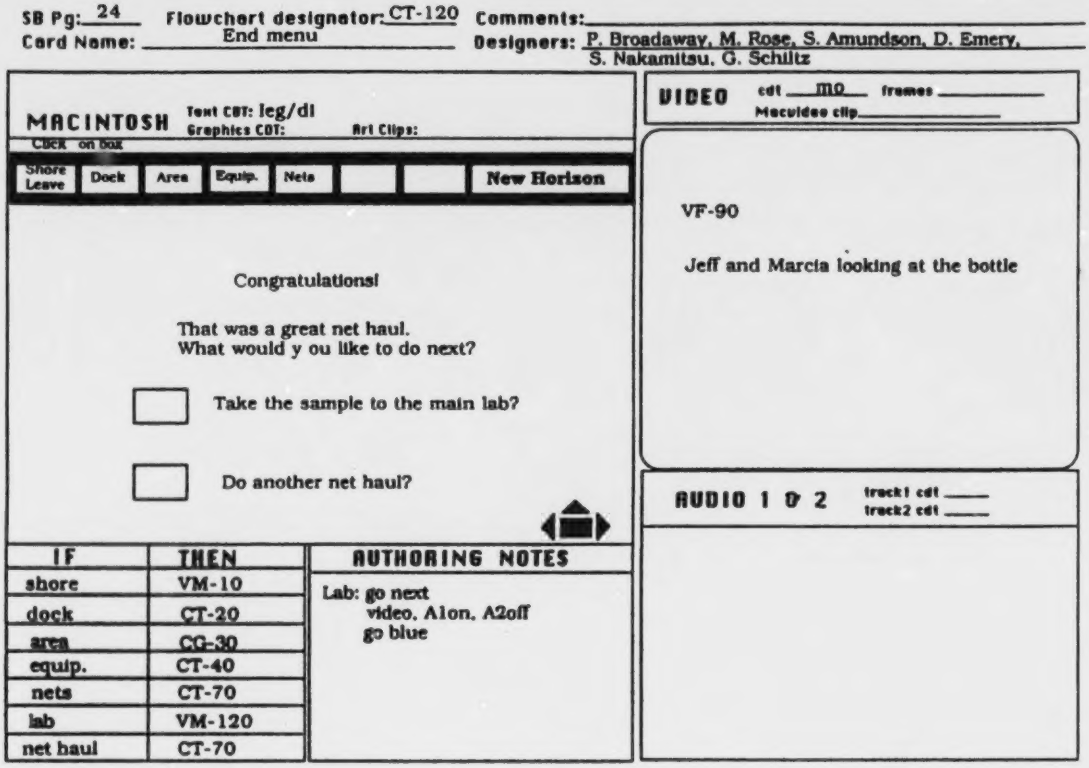
track2 cdt

IF	THEN
shore	VM-10
dock	CT-20
area	CG-30
equip.	CT-40
nets	CT-70
plant	VM-70
animal	VM-80

link plant and animal back to this card.

Net haul goes to VM-90

Figure 3. Sample storyboard specifications for menu from *Exploring an Oceanographic Research Vessel*. Band of buttons at the top of proposed HyperCard display is a "main menu" (available at numerous locations throughout the program) which indicates where viewer is located. Abbreviations: VF = video freeze, VM = video motion, CT = computer text, CG = computer graphics. Mo = motivator, EG/ntk = expository generality/nice-to-know.



MACINTOSH
VIDEO
AUDIO 1 & 2
Click on box
Shore Leave
Dock
Area
Equip.
Nets
New Horizon
track1 cdt
track2 cdt
frames
Macvideo clip
Graphics CDT:
Art Clips:

SB Pg: 24 Flowchart designator: CT-120 Comments:

Card Name: End menu Designers: P. Broadaway, M. Rose, S. Amundson, D. Emery, S. Nakamitsu, G. Schiltz

Text CBT: leg/dl

VIDEO cdt mo

Congratulations!

That was a great net haul.
What would y ou like to do next?

☐ Take the sample to the main lab?

☐ Do another net haul?

VF-90

Jeff and Marcia looking at the bottle

IF	THEN
shore	VM-10
dock	CT-20
area	CG-30
equip.	CT-40
nets	CT-70
lab	VM-120
net haul	CT-70

AUTHORING NOTES

Lab: go next
video. A1on. A2off
go blue

Figure 4. Sample storyboard specifications for a menu from *Exploring an Oceanographic Research Vessel.* Ieg/di = inquisitory instance/directions.

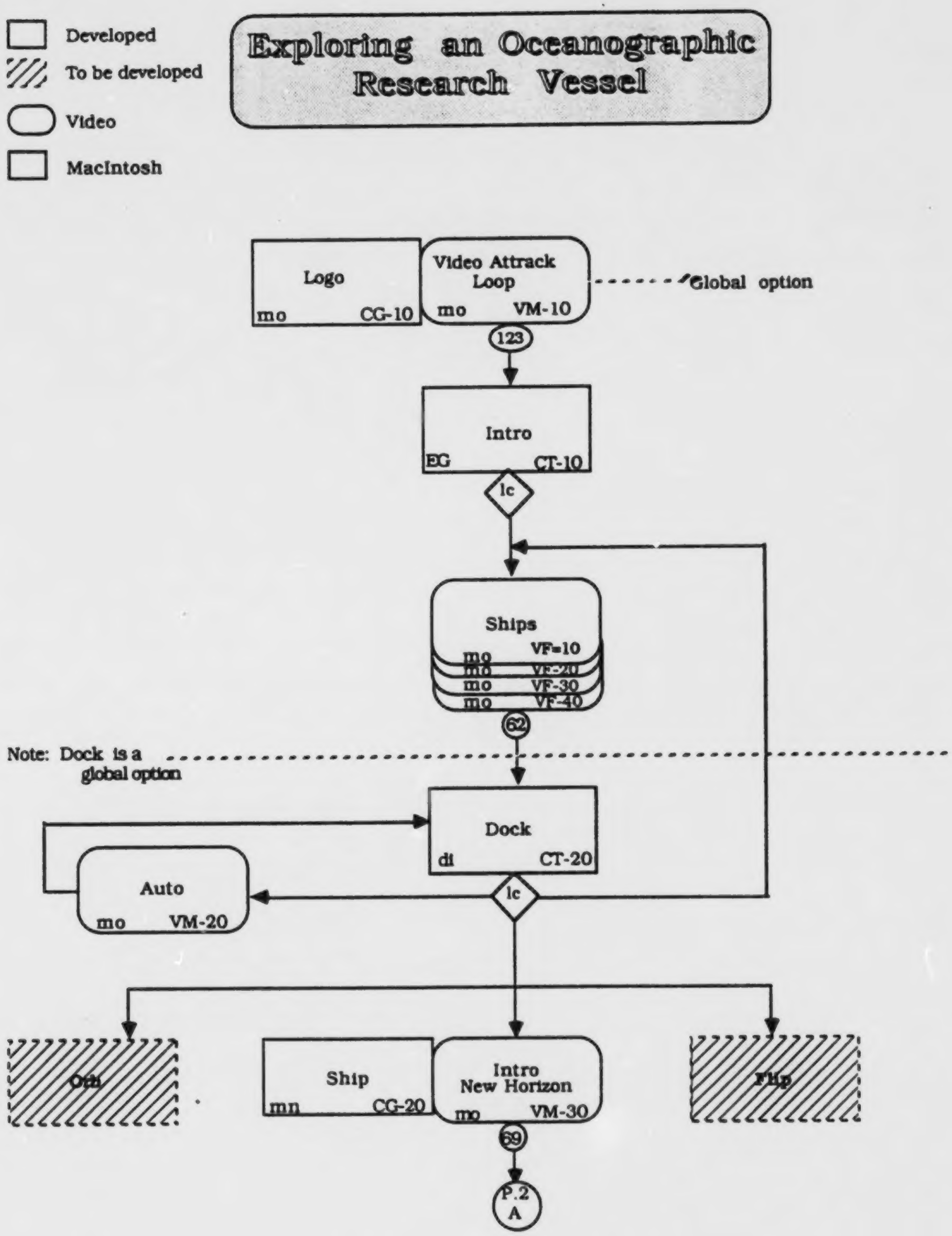

Developed
To be developed
Video
Macintosh
Exploring an Oceanographic Research Vessel
Logo
mo
CG-10
Video Attrack Loop
mo
VM-10
Global option
123
Intro
EG
CT-10
lc
Ships
mo
VF-10
mo
VF-20
mo
VF-30
mo
VF-40
62
Note: Dock is a global option
Dock
di
CT-20
Auto
mo
VM-20
lc
Oth
Ship
mn
CG-20
Intro New Horizon
mo
VM-30
Flip
69
P.2
A

Figure 5. Excerpt from flowchart detail for *Exploring an Oceanographic Research Vessel.*

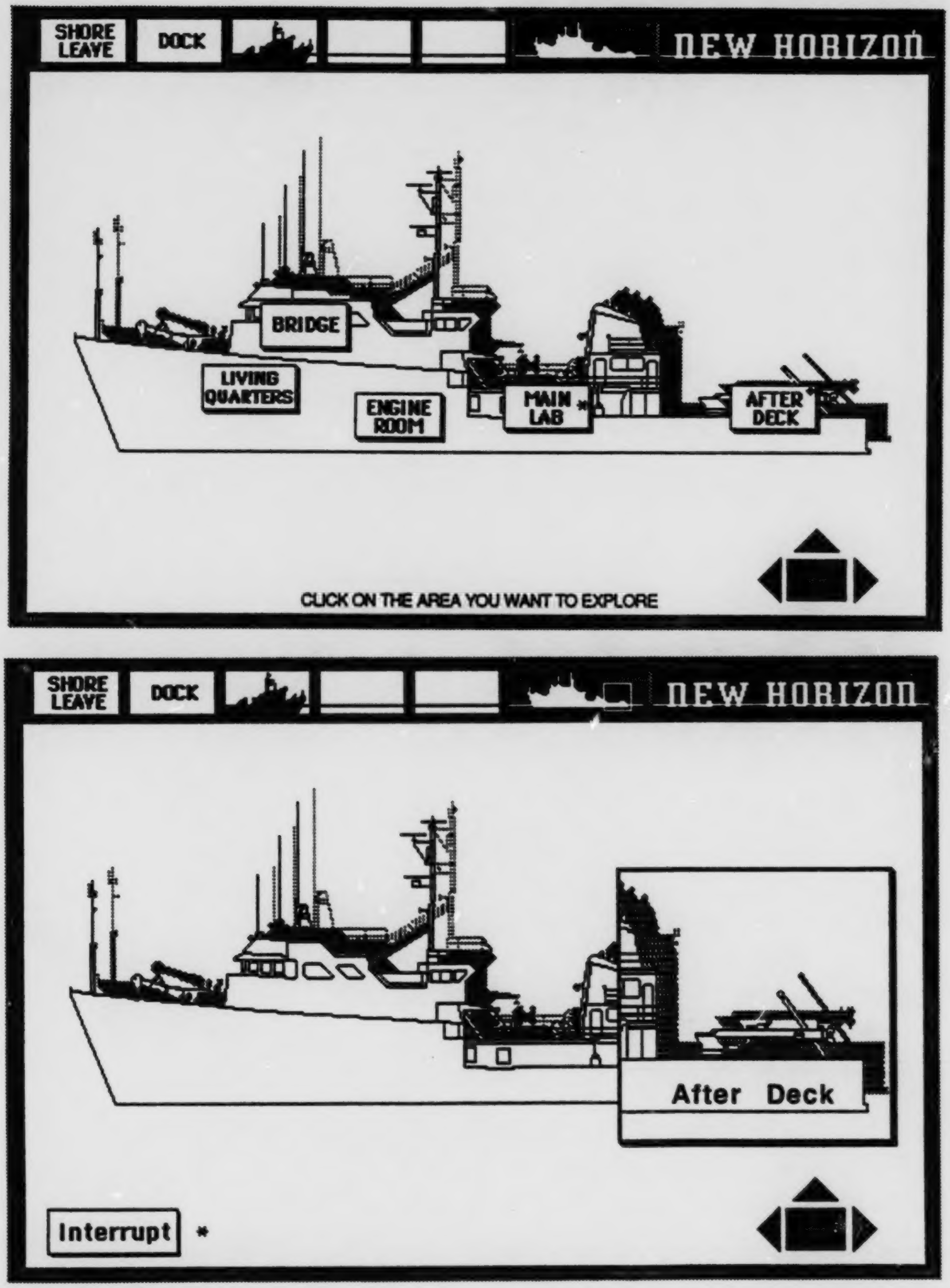
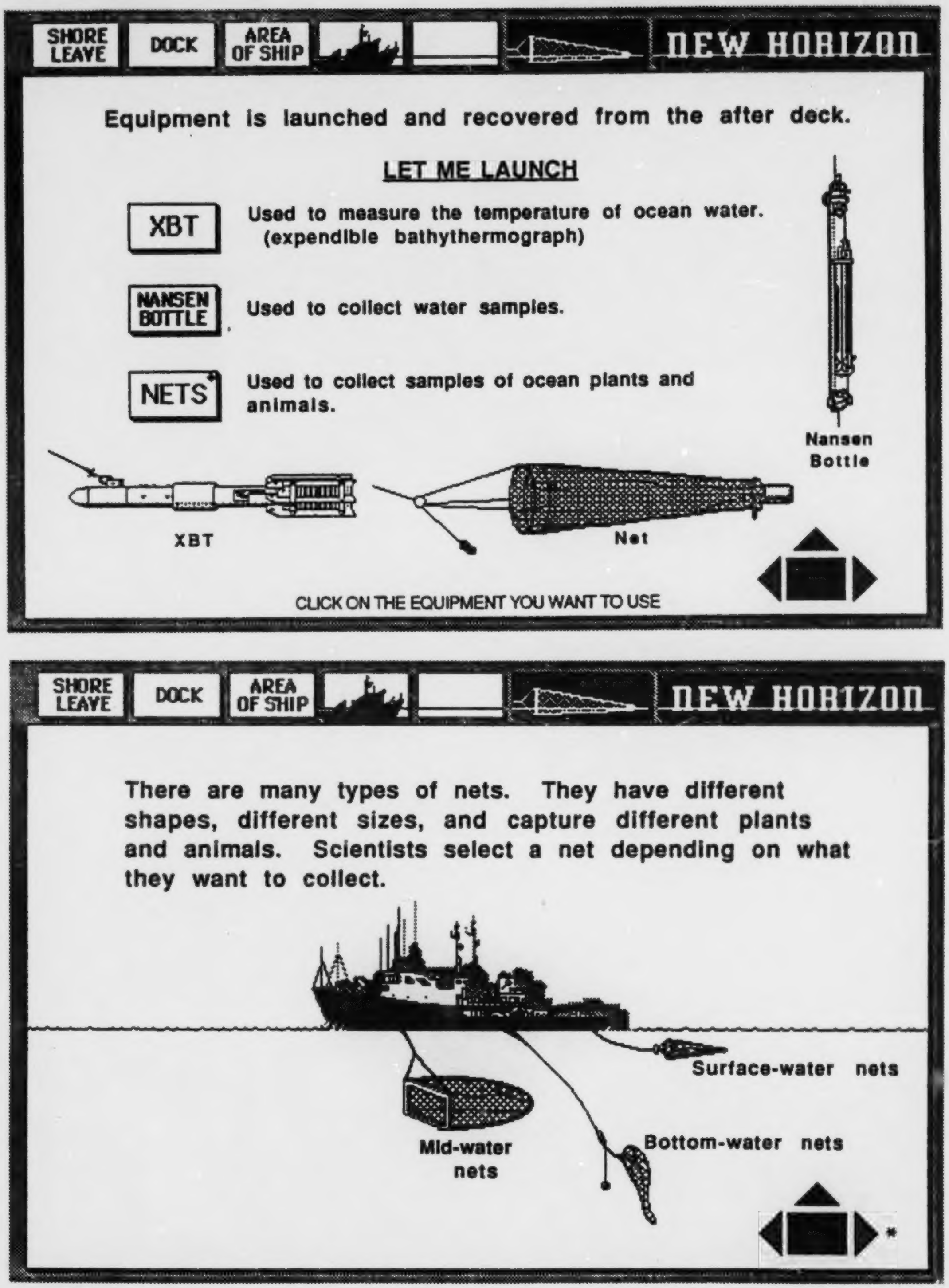

SHORE LEAVE
DOCK
NEW HORIZON
BRIDGE
LIVING QUARTERS
ENGINE ROOM
MAIN LAB
AFTER DECK
CLICK ON THE AREA YOU WANT TO EXPLORE
SHORE LEAVE
DOCK
NEW HORIZON
After Deck
Interrupt

Figure 6. Sample HyperCard screens from *Exploring an Oceanographic Research Vessel.* Labeled buttons permit visitor to select location for "tour" via video segment.


SHORE LEAVE
DOCK
AREA OF SHIP
NEW HORIZON
LET ME LAUNCH
XBT
NANSEN BOTTLE
NETS
Nansen Bottle
XBT
Net

Equipment is launched and recovered from the after deck.

XBT Used to measure the temperature of ocean water. (expendible bathythermograph)

NANSEN BOTTLE Used to collect water samples.

NETS Used to collect samples of ocean plants and animals.

CLICK ON THE EQUIPMENT YOU WANT TO USE

SHORE LEAVE
DOCK
AREA OF SHIP
NEW HORIZON
Surface-water nets
Mid-water nets
Bottom-water nets

There are many types of nets. They have different shapes, different sizes, and capture different plants and animals. Scientists select a net depending on what they want to collect.

Figure 7. Sample HyperCard screens from *Exploring an Oceanographic Research Vessel.* Menu permits visitor to select specimen collecting devices. Once selected, viewer sees video segment showing how crew launches and operates device.

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THE USER INTERFACE IN INTERACTIVE SYSTEMS

Greg Baur, Western Kentucky University

Abstract

The user interface is an important component of an interactive system because it represents the totality of communications between the user and the system. The use of input devices and screen design are key areas of consideration in the building of an interactive system. The purpose of this paper is to give guidelines for system developers in these two areas.

Introduction

Advances in technology has given new importance to the user interface. As more and more people have become users of interactive systems, systems developers have found that the use of input devices and screen design must be more carefully considered than ever before. A wide variety of input devices, including the keyboard (both data and cursor control keys), mouse, touch-sensitive screen, light pen and voice among others, that may be used. There are also a number of screen design formats, such as question and answer, selection, hierarchical menu (horizontal choices), pull-down menu (vertical list), icons and windows. What are the key considerations for the use of input devices and screen design formats? In the paper we will discuss some guidelines that should be used by interactive system developers.

Guidelines for the use of Input Devices

In this section we will look at guidelines for implementing interaction through screen displays. Interaction between the user an the system is sometimes called *dialogue*, similar to a conversation between two individuals. Besides considering rules for implementing effective dialogue, we will explore general rules for using different input devices.

1. **Minimize the number of key strokes.** To perform tasks and move between menus, the number of keystrokes, or other required actions, to complete the functions should be as few as possible. If users are working with codes, they should be short in length. The depth of menus should be taken into consideration at design time.

2. **Use a two-level command or menu selection structure.** If the system is driven by commands, or a menu, then the instructions should exist at two levels, one for the beginner and one for the more experienced user. A beginning user does not mind selecting "D" for document, "P" for print, and "Go" to start the process of printing. As the user gains experience, this three step process, is abbreviated to entering DPG (in one step). The same principle should be applied to menu selection when the user is very familiar with the system. This two-level command or menu selection structure is accommodating to users with different levels of expertise in using a system.

3. **Help the user navigate through the system.** Effective dialogue and functionality are fostered when the user understands how to progress through a system. This concept is analogous to reading the symbols on a roadmap. To determine which way to go, the symbols (or prompts) must be understood. Likewise, in a computer or interactive system, the user must recognize whether they are in the mode to look at production rules, change a rule, or observe the execution of a set of rules. They also must understand how to move from one mode to another. Proper symbols and understanding of how to navigate through a system are important for the user.

4. **Provide on-line help.** If the user is unsure of backward chaining, he or she should be able to invoke the help system. If the user does not remember what information is to be entered, then an on-line help option could prompt the user. On-line help is supplementary to the formal training for and written documentation of the system. These help systems are considered standard features, not only to interactive systems, but to any computer information system.

5. **Quick response time should be guaranteed.** Response time is the amount of time (in seconds or smaller time units) that it takes for the computer system to respond to the user input. Users on mainframe or microcomputer systems are accustomed to a short (1 to 3 second) response time. No one likes to wait to get the task completed. This is particularly important in multiuser or networked systems. The response time is a function of both the hardware and the software. Response time is important at design time and also after the system is implemented because of continual changes in the system and working environment.

6. **Avoid blank screens during any dialogue session.** As a response in a dialogue session, the user should see an appropriate response. Many times, there are searching and sorting techniques that, unfortunately, take considerable time (or so it seems). Instead of leaving the display screen blank, some message appropriate to the task should appear to the user. For example, if the interactive system, is firing a rule base, then a message such as "Searching the rule base" should appear on the screen. Users are likely to be more patient if there is an explanation for the lapse of time. Hence, for the user, appropriate messages are preferred to blank screens.

7. **Implement an undo feature in the commands.** An undo command is one that reverses a command or action that has just been implemented: However, not all actions in a system are reversible or undoable. Users have become accustomed to this helpful system interface, making the implementation of the feature by programmers a useful design enhancement.

8. **Simplify error messages.**Error messages, warning messages, and other related feedback should be in terms that are understood by the user. They are information to the user, not the programmer. For example, a message, "Check disk drive door to make sure it is closed," is a better feedback to the user than "System failure: abort, retry?" Messages like "syntax error" or "Runtime error 256" are not particularly useful to users. In addition, users should be involved in approving the messages that are built into the operation of an interactive system, to ensure their understanding of them.

9. **Provide for atypical users.** Most computer systems are designed for people who have 20/20 vision, are right handed, and have full-color vision. Many people, however, have vision problems, are color-blind, or are left handed. Input devises such as numeric keypad, or trackball, may be difficult for left-handed users. Color display screens, for color-blind users, should appear readable and discernible on black and white monitors. An interactive system that is to be used by a wide variety of users must take into consideration the atypical user.

10. **Minimize the number of changes.** If the keyboard system is combined with another device such as a mouse or light pen, minimize the changes from keyboard to the other devices. When another input device is used together with the keyboard, frequent changes between the two styles can be confusing.

Guidelines for Screen Display

Some general guidelines or directions for effective **screen display** in interactive systems are described as follows.

1. **Use uncluttered, well-spaced screens.** The user screens should be uncluttered with appropriate spacing between fields, lines, and text. Experts advise that only 15 to 20 percent of the screen space should be utilized. Unnecessary items are distracting to the task at hand.

2. **Avoid paragraphs of text at the screen.** Paragraphs of text should rarely be used on the screen. Reading from a display terminal is not the same as reading from or browsing through a book, so organize information into vertical lists instead of paragraphs. If paragraphs are necessary, however, display part of the text, then allow the user to press a key to continue with the next part. A mixture of upper-case and lower-case text is more readable than using all capitals.

3. **In general, left-justify text and right-justify numbers.** Text and number lists should be distinctly formatted. Lists of text should be left justified; that is, the leftmost letter of each word in the list should be aligned vertically to the left. In contrast, numbers should be right justified, aligned vertically to the right. When using decimal values with varying decimal places, the list of numbers should be decimal aligned.

These examples are shown below:

Left Justify	Right Justify	Decimal Align
Investments	4,300	34.78
Stocks	543	123.6
Bonds	678,413	6.789

This arrangement of lists is easiest for the user to read.

4. **Limit the number of menu selections from five to seven.** In general, a user can retain information from about seven items at a time. Therefore, the number of selections from a single menu or pull-down submenu should be limited to between five and seven items. Each one should be numbered (1,2,3 etc.). Use letters only with a short menu list of three or four selections identified by codes (i.e., D for delete, U for update, or A for add). The items can be listed by time, function, number, importance, or other criteria. A general rule of thumb, however, is to list the menu options by frequency of use, with the most frequently used at the top or left of the menu screen (breadth) and by the *highest* level of menu (depth).

5. **Be consistent in wording and location of prompts.** The wording and location of prompts, fields, and other identifiers should be consistent throughout the screens. Use uniform wording of phrases. For example, do not use change the record on one screen and *update* the record on another. With date entry fields, maintain the same formats for name, social security number, date, and so on throughout all screens. The screen formats should match the formats used in printed reports. The prompts to the user should always appear in a corresponding location. If the lower-left hand corner of the screen is used to display the message on how to move to the next screen, retain that relative positioning in all appropriate screens. Keep the language consistent with the expectations of the user of the system. This means to adhere to the vocabulary of the user. If the user is an accountant, then the term debit and credit are fine, but they are not appropriate for the general user referring to money paid in and money paid out.

6. **Use reversed videos or color for data entry fields.** If a user is filling in the various items on a form-like screen, each data entry field should be highlighted. Reversed video (the opposite of the screen background: black letters on a white background or white letters on black background) is one popular method in many business-oriented information systems. Color is another way to draw attention to a particular

field. Windowing is still another technique used to highlight the fields to be used. The system should not permit the user to alter information or words that are not to be changed on the screen. In other words, the programmer should "protect" these screens when the screen programs are being implemented.

7. **Use color and graphics to add to screen design.** Color can be a useful asset to screen design if it is available on the video system. It can be used to highlight; to readable. Color on diagrams makes intricate detail more discernible for the user. Care should be taken in selecting the color of the background (blank screen) and the color of the text that appears on the screen. Certain color combinations are hard to read, such as red letters on a blue background, for example. The designer of the system should make sure that if the color screens are displayed on a black and white monitor, that the visual effects of the screen are still discernible and pleasing to the eye.

8. **Let the user select some characteristics of the screen interface.** For those applications where usage is extensive by the same user, some method of configuring or tailoring the screen environment for the individual should be available. For example, if color is used, then the user should be able to select certain colors for his or her working environment. If a beep or sound is used to identify the end of a field or other warning, then the user should be able to turn the noise or sound off. Different people have different reactions to color, sound, and so on, and these minor characteristics can be very annoying to those who use the system continually. If the users, on the other hand, vary from day to day, then the screen characteristics should be determined by the designer of the system. Advising systems used by the general public are a type of interactive system where each user should not be allowed to change the characteristics of the terminal display.

The preceding rules are to be considered as guidelines for general screen design for interactive systems. The more specific and narrow the domain of the interactive system, the more these rules may have to be adjusted to fit the functional needs of the specific interactive system application

These guidelines are to be considered during the design stage of the interactive system life cycle. Incorporating user-friendly procedures is easiest and most effective during the design stage. The best judge of a user interface is not a given set of rules, but an evaluation by the user. Attention to the user interface design will reap countless benefits to the acceptability, functionality, and efficiency of the intended interactive system.

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ADDING RESEARCH TOOLS TO COMPUTER-BASED VIDEO INSTRUCTION PROGRAMS

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Abstract

Methods of adding research tools to *computer-based video instruction* (CBVI) programs are discussed. IBM's InfoWindow Presentation System (IWPS) authoring system, with IBM's InfoWindow® Touch Display, is used as an example of one CBVI environment. Segments will be used to illustrate the addition of research tools to a CBVI program, for example, learners' demographic data gathered by the author-developed Subject Information Form (SIF) tool.

Introduction

Research and development techniques are used to build knowledge and understanding of how different teaching media and methods affect learning (Laurillard, 1987, p. 74). In pedagogical designs for *computer-based video instruction* (CBVI), therefore, accompanying research tools are often planned. These are usually paper-and-pencil. Today, I will discuss methods of adding computer-based research tools to CBVI programs. I used CBVI for my dissertation research on learner control options (Hassett, 1989, Nov. 13-15; Hassett, 1991, anticipated). Originally, paper-and-pencil tools were planned, with the exception of the Embedded Content Questions tool (CBVI items). After designing the CBVI program and entering the authoring stage, I determined to add other research tools to the instructional design. I will use this experience as an example and share about these tools. All but one of the planned paper-and-pencil tools were adapted to become computer-based tools.

Review of Literature

The literature on adding research tools to CBVI programs is limited. Three articles lend some support to the subject. Aiken and Mikan summarized selected items on computer use in 550 undergraduate nursing programs (United States). These were results of a national survey conducted in 1987 and repeated in 1988. Findings on nursing program administrators who responded "Yes" to *non-instructional uses of computers* ($\underline{N} = 509$, in 1988) included: 53 percent for calculation (grades), 39 percent reports, 25 percent data management, and 24 percent for data analysis (1989, p. 106).

Boyce and Rieber (1989) compared student responses to a *paper-and-pencil* faculty evaluation tool versus a *computer-based* tool having the same items. The computer-based tool was not added to a CBVI program. However, findings lend support to adapting existing paper-and-pencil tools to computer-based ones without significant differences in student responses. There were no significant differences in time taken to complete either tool. And few significant differences were found between student responses for each item; for example, students using the computer-based tool included more open-ended comments.

Rizzolo's three-round Delphi study (1990) identified factors that experts believe *impede* the development and use of CBVI in nursing education. Nurse educators with experience in CBVI development were the identified experts ($N = 31$). Results included one of the essential features of exemplary CBVI programs as: record keeping for research on CBVI programs ($M = 4.29$ [agreement received ratings of 4 or 5], $sd = .74$, $rank = 12$ [out of 22]; p. 156).

Methods

Methods of *adding research tools* to CBVI programs are these: (a) add before the main program begins; (b) add after the main program ends; (c) add to the main program itself (if one is the author); and (d) a combination (e.g., add a tool before and another after the main program). The added tools may be run during the program by adding them to the authoring phase. This is what I did; however, the added tools do not have to be incorporated into the main program. They may also be run separately, prior to or after the program (for example, using a computer language program such as one written in C). The added research tools may also be run by attaching them to the existing program (such as, by using a DOS batch file). Data handling should allow the researcher automated access to subjects' data.

If a desired paper-and-pencil tool is protected by copyright, then permission must be obtained before adapting it to a computer-based tool (Copyright basics, 1989; Copyright law, 1989; International, 1989). If a computer-based tool is available to add, and is protected by copyright, then permission must be obtained before adding the computer-based tool to a CBVI program (Boyden, 1984; Copyright registration, 1986).

Example

I will show segments of added research tools today as an example of one CBVI environment. I used IBM's InfoWindow Presentation System (IWPS) authoring system (1986) with an IBM InfoWindow® Touch Display for the CBVI program with research tools added. An IBM PS/2® Model 70 microcomputer was used, with DOS 4.01. The IBM *InfoWindow System* is presented as an example of one CBVI environment.

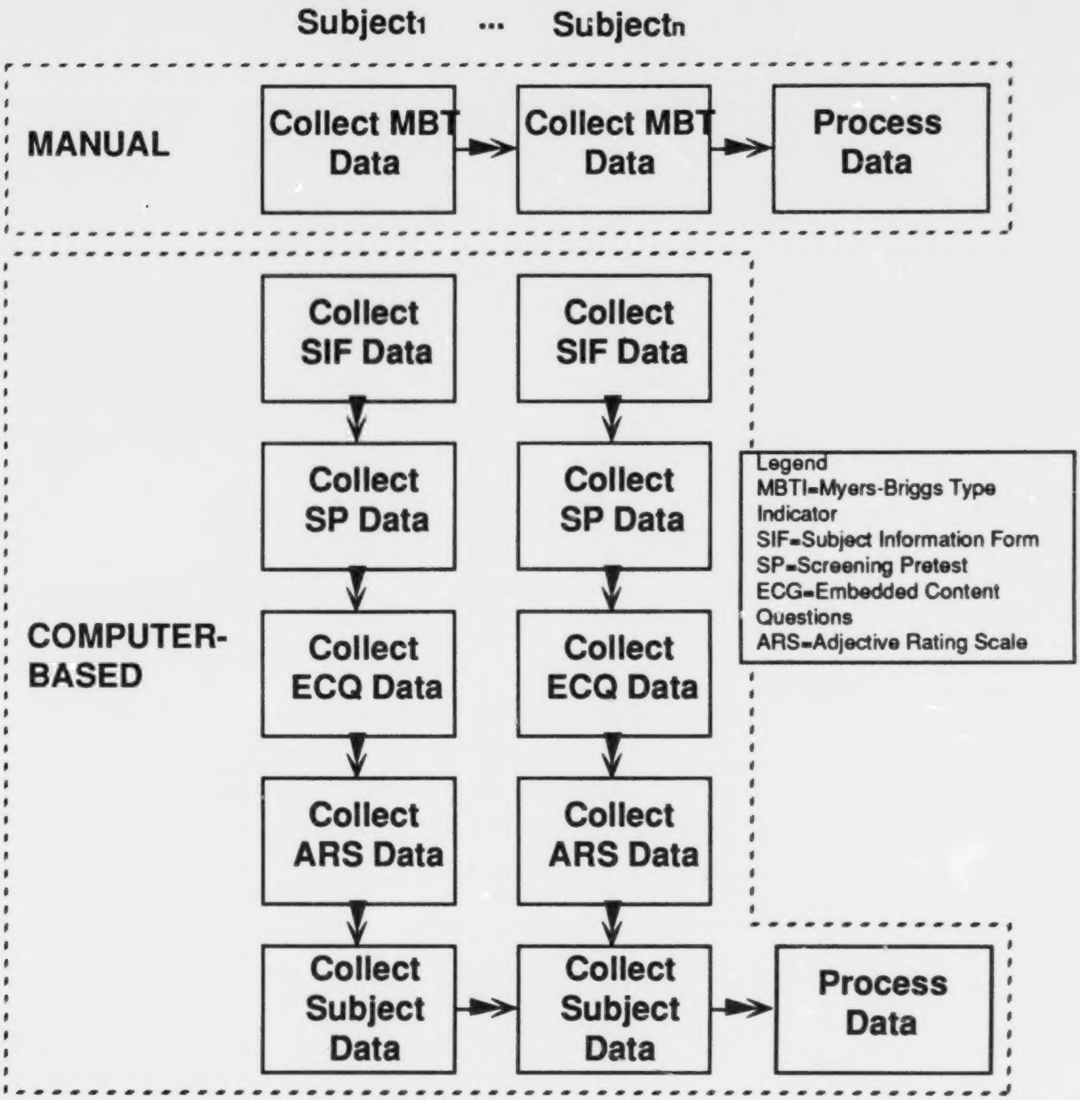
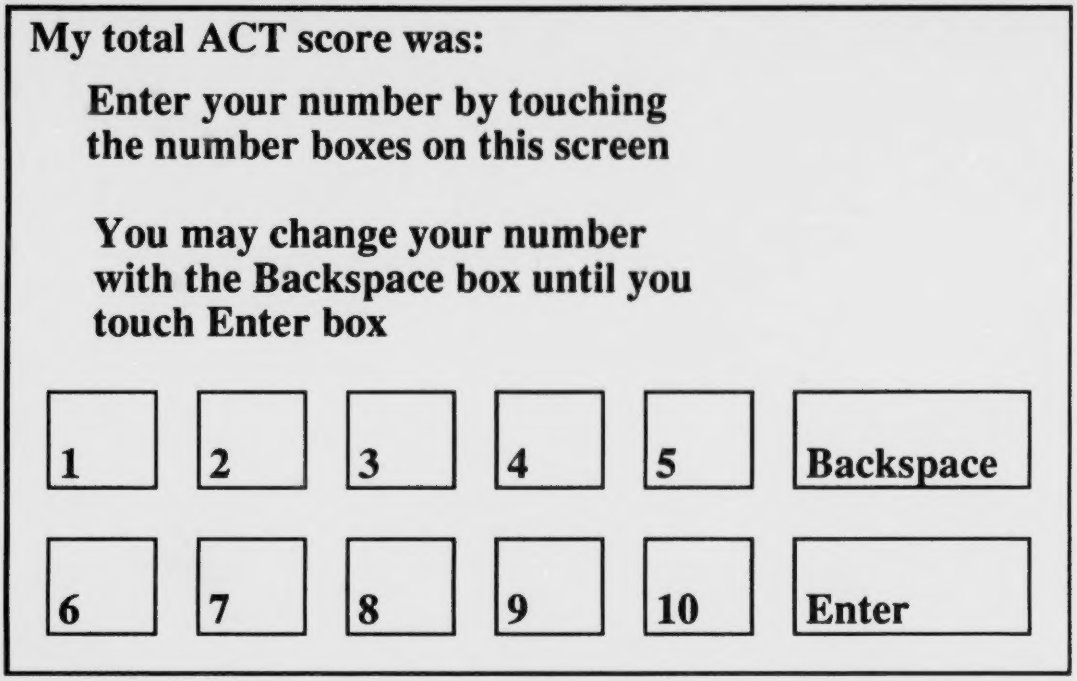

Subject1 ··· Subjectn
MANUAL
Collect MBTI Data
Collect MBTI Data
Process Data
COMPUTER-BASED
Collect SIF Data
Collect SP Data
Collect ECQ Data
Collect ARS Data
Collect Subject Data
Process Data
Legend
MBTI=Myers-Briggs Type Indicator
SIF=Subject Information Form
SP=Screening Pretest
ECG=Embedded Content Questions
ARS=Adjective Rating Scale

Figure 1. Manual and Computer-Based Research Tools.

Other authoring systems could be used to run computer-based research tools, or a programming language could be employed, such as Assembly, BASIC or C. Major strengths of the InfoWindow System include (a) graphic overlay and control for both touch-screen and voice synthesis functions on an intelligent terminal, (b) random access to videodisc segments (Lambert, 1987, p. 99; Hannafin & Peck, 1988, pp. 357-358), (c) the ability to run video images and graphics on the same display, and (d) capability for user exit calls to C language programs or code modules.

IBM's IWPS authoring software [Level 051(A)] was used to adapt the research tools (1989, Aug. 3). Three tools were added to the CBVI program within a reasonable period of time (3 weeks) by using a rapid prototyping approach (Hassett, 1990). Two of these tools were author-developed and the other is public domain. I was surprised at how much graphics creation was necessary in order to add the tools.

The text for each added tool had been word processed ahead of time because of the intention to print paper-and-pencil versions. I imported the word processed tools directly into IWPS by: (a) isolating each item to a single "screen" in my word processor (I changed the background and character colors to vary the screens, and stripped off the WordStar v. 5.5 menu bar, etc.), (b) capturing each isolated screen with the Picture Taker function of IBM's Storyboard Plus Version 2.00 graphics package (IBM Storyboard, 1989, June, Ch. 3), (c) using the IWPS Process Graphics option to import



My total ACT score was:

Enter your number by touching the number boxes on this screen

You may change your number with the Backspace box until you touch Enter box

Figure 2. Subject Information Form: Sample Computer-based Screen with Author-defined Touch-Sensitive Keypad.

screens from Storyboard (IWPS Editor, 1986, p. 7-1), and (d) adding graphics panels to the imported screens, for buttons, etc., by importing them from Storyboard as overlays (IWPS Editor, 1986, p. 7-11). See Figure 2 for a sample screen that combined captured word processed text with a graphic overlay: an author-defined touch sensitive keyboard (IWPS Editor, 1986, p. 9-79).

I will now discuss the method of adding research tools to my program. I used the combination method, that is, I added two tools before and another after the CBVI program (incorporating them into the program). Figure 1 depicts data collection for subjects by research tool(The ECQ was planned as computer-based (CBVI) from the outset; its boxes are shaded on Figure 1.)

Add before the Program Begins. The author-developed Subject Information Form (SIF) tool (Hassett, 1989c) was added to collect five areas of learner demographic data. A sample SIF screen is found in Figure 2. The Screening Pretest (SP), also author-developed, was added to collect baseline subject knowledge immediately prior to the CBVI content modules (Hassett, 1989b).

Add after the Program Ends. The Adjective Rating Scale (ARS) was added immediately after the CBVI program. Kelly, Pascarella, Terenzini, and Chapman developed the ARS, a public domain tool that measures attitudes toward courses and programs (1976).

Add to the Program Itself. The author-developed Embedded Content Questions (ECQ) tool (Hassett, 1989a) was already a part of the main CBVI program and did not need to be added.

Data handling. The researcher needs automated access to the subjects' data. When I collected data for a Pilot Study and then dissertation study data, there was an easy method for accessing the individual subject data. here was no method for aggregating the data except manually. Since then, I had a program written in Microsoft C that places the data from each subject in an aggregate table(Later, statistical programming will be added.)

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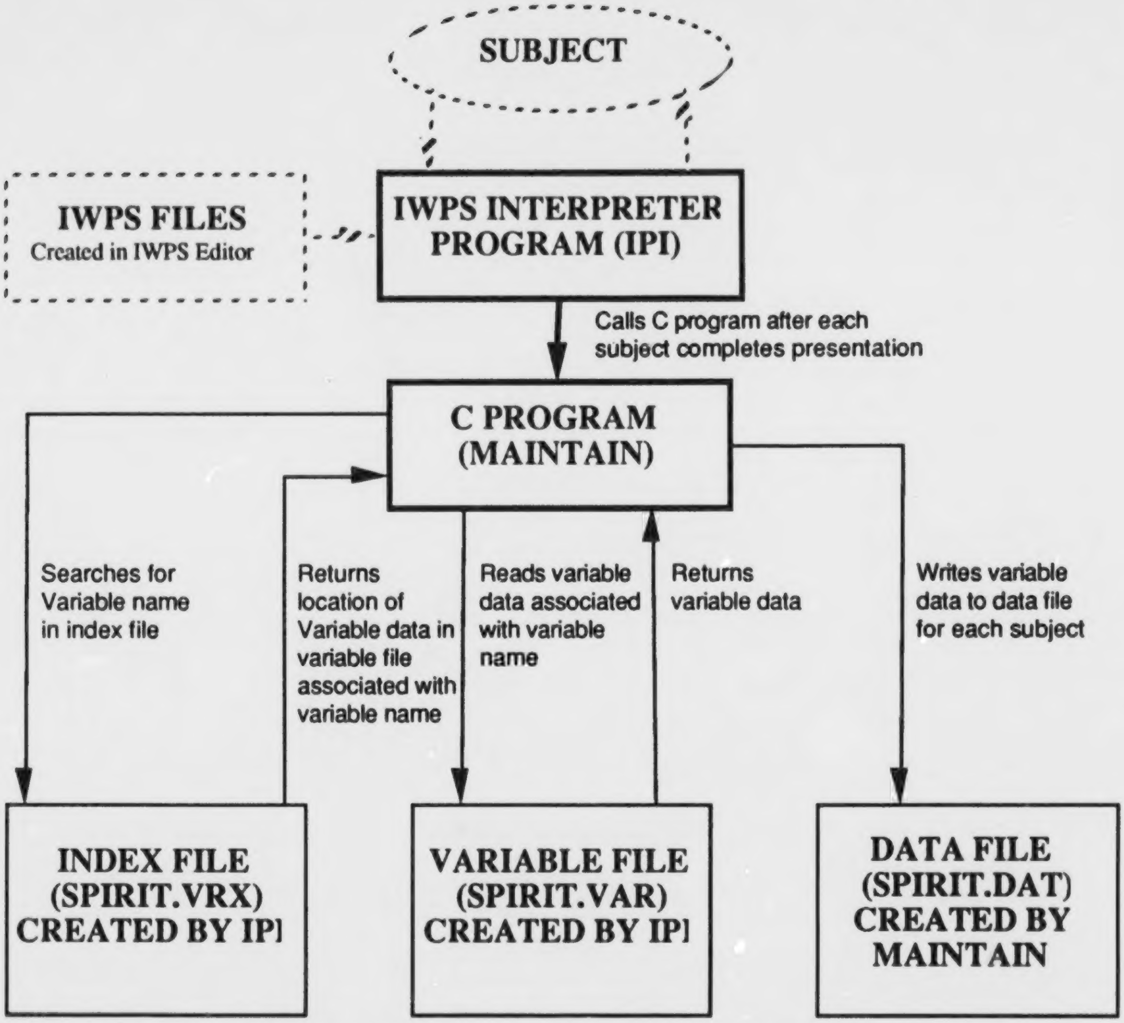
SUBJECT
IWPS FILES
Created in IWPS Editor
IWPS INTERPRETER PROGRAM (IPI)
Calls C program after each subject completes presentation
C PROGRAM (MAINTAIN)
Searches for Variable name in index file
Returns location of Variable data in variable file associated with variable name
Reads variable data associated with variable name
Returns variable data
Writes variable data to data file for each subject
INDEX FILE (SPIRIT.VRX) CREATED BY IPI
VARIABLE FILE (SPIRIT.VAR) CREATED BY IPI
DATA FILE (SPIRIT.DAT) CREATED BY MAINTAIN

Figure 3. Maintenance: Logical Sequence of Events to Automate Data Collection Using Computer-based Research Tools for Spiritual Assessment CBVI Program.

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ARE INSTRUCTIONAL ORGANIZERS EFFECTIVE WHEN USED IN COMPUTER-BASED INTERACTIVE VIDEO?

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Abstract

The purpose of this literature review was to examine the research concerning the effectiveness of instructional organizers when used in the design of instruction for Computer-Based Interactive Video (CBIV). Three techniques - the advance organizer, the structured overview form of graphic organizer and the pictorial graphic organizer - were considered. Two questions were asked. Do they work at all? Are they effective with CBIV? The evidence will be considered in light of the original theories, past and current research results. An alternate explanation will be advanced based on Wittrock's Generative Learning Hypothesis and recommendations made for future research.

Introduction

The purpose of this paper is to review the research literature pertaining to the use of instructional organizers with a view to which, if any, would be effective when applied to instruction using Computer-Based Interactive Video (CBIV). Instructional organizers are those given before, during and after, the lesson and include advance organizers and its offshoots, structured overview graphic organizers and pictorial graphic organizers. The review will first consider what evidence there is that any of these techniques have an effect on learning (immediate recall) or retention. Do they work at all?

Second, it will look at the relevant research on CBIV to determine if these techniques have been successfully applied to the medium. Even if they are useful elsewhere, will instructional organizers be effective when used in instruction presented by CBIV? Why CBIV? It is a medium which combines the power of the computer to support student interaction and involvement with the richness of the various audio and visual media to offer the capability of producing multi-media student-centered learning environments. As such, it may provide a glimpse of the classroom of the future (Simonson and Thompson, 1990). Determining which instructional design techniques are effective when used with CBIV could provide useful recommendations to those who wish to develop instruction using this powerful new medium.

Instructional Organizers. All types of instructional organizers originated with the concept of advance organizer first proposed by David Ausubel (1960, 1963). While their differences lie both in the design and placement in the instructional sequence, the purpose of these organizers are similar. They are instructional techniques designed to relate the material-to-be-learned to the learner's existing cognitive structure to facilitate learning and retention.

The Advance Organizer. The purpose of the advance organizer is to facilitate the learning and retention of meaningful verbal information. Ausubel's Subsumption Theory postulates that cognitive structure is hierarchically organized in terms of highly inclusive concepts under which are subsumed less inclusive subconcepts and informational data

> ... [and, further] ... it is reasonable to suppose that new meaningful material becomes incorporated into cognitive structure in so far as it is subsumable under relevant existing concepts ... [Thus]... the availability of appropriate and stable subsumers should enhance the incorporability of such material (Ausubel, 1960, p.267).

Advance organizers are introduced in advance of the learning material itself and are presented at a higher level of abstraction, generality and inclusiveness (Ausubel, 1963). Their main function is to bridge the gap between the learner's cognitive structure and the material-to-be-learned and must be stated in terms familiar to the learner (Ausubel, Novak and Hanesian, 1978). Ausubel proposed two varieties:

1. *the expository organizer:* to be used when the learning material is unfamiliar and meant to provide an ideational umbrella under which to incorporate the new material.
2. *the comparative organizer:* to be used to integrate new ideas with basically similar ones in cognitive structure by pointing out the similarities and differences between them.

The Structured Overview Graphic Organizer. The second technique to be considered was first advanced as a "structural overview" by Barron (1969) as a modification of the advance organizer. In this approach, tree diagrams introducing the new vocabulary to be used in the material-to-be-learned were developed as a comprehension aid for low ability learners. It used the spatial characteristics of diagrams to indicate the relationships and distances between key terms (Hawk, McLeod and Jonassen, 1985).

Barron (1969) believed that the structured overview assumed the properties of advance organizers because it was intended to relate new content information to relevant subsuming concepts in the learner's cognitive structure. Alvermann (1981), however, noted that graphic organizers were unlike advance organizers for two reasons: they were written at the same, rather than a higher or more abstract, level as the to-be-learned material and they use lines, arrows and spatial arrangement to depict text structure and relationships among key vocabulary. While Ausubel does not exclude diagrammatic material, the first point would clearly distinguish structured overviews from advance organizers.

While Barron (1969) first referred to the technique as the structured overview, he later accepted Ausubel's advice to rename the technique "graphic organizer" (e.g. Barron and Stone, 1974). Brown, Padron, and Rivera (1988) note that graphic organizers follow five general patterns: cause/effect, comparison/contrast, time/order, simple listing and problem/solution.

The Pictorial Graphic Organizer. Hawk, McLeod and Jonassen have further developed Barron's modification. Their form of organizer is a more pictorial, visual, or graphic presentation than any of the organizers referred to earlier [advance organizers or the structured overview form of graphic organizer] (Hawk, 1986). These pictorial graphic organizers take one of two forms: participatory organizers, in which students participate in the completion of the organizer, and final form organizers, in which they do not (Jonassen and Hawk, 1984).

Scope of the Review

This review is meant to be exploratory, to answer the question: Is there any evidence to justify the use of these techniques in CBIV instruction? With that in mind, a computerized search of ERIC and PsychLit was first carried out to assess the current and recent state of the literature for each topic; that is, back to approximately 1975. Second, the references included with various articles located by the computer search provided an indication of the seminal articles for each topic.

The literature on advance organizers dates back at least thirty years to David Ausubel's (1960) article recounting his study of 120 college students who received an expository advance organizer prior to learning material on metallurgy. That literature is extensive. Even ten years ago, Mayer (1979) noted in his review of the topic that hundreds of studies and dozens of reviews had been published since the 1960 paper. Since the purpose of this review is to gain an overview of the topic and discern how it applies to CBIV, the section pertaining to advance organizers will consider only published studies and will summarize several well referenced reviews on the topic. A caveat is that this approach may leave the review open to the effects of publication bias and lead to overly positive conclusions. There is, however, considerable variation in study design and methodological rigor within the studies included.

By contrast, the research on the structured overview graphic organizer and the pictorial graphic organizer appears to be much more limited. Consequently, all papers which could be obtained to this point in time, including published studies, conference presentations, and textbook chapters, have been included. Similarly, the literature pertaining to CBIV is also sparse and all sources obtained have been included.

Advance Organizers

Do advance organizers work as Ausubel claimed? He, of course, provided evidence that it did. For example, one of his first studies, testing undergraduates on their learning from a 2500 word passage on metallurgy produced statistically significant results in favor of the group receiving the advance organizer (Ausubel, 1960). Many studies have examined the construct since and not all have been as supportive of the claim. Hartley and Davies (1976) reviewed advance organizers as a part of a broader overview of preinstructional strategies. They noted that the most favorable studies were the initial ones but that they were of limited generality. Some of the best controlled studies to that date produced mixed results. In spite of the mixed evidence, they concluded that, in the majority of studies, advance organizers did facilitate both learning and retention. A major problem, they pointed out, lay in the design and writing of advance organizers because there were no procedures nor operationally defined steps for generating them. Ausubel, though, vociferously disputed this on at least two occasions (Ausubel, 1978, Ausubel, Novak & Hanesian, 1978). He refers readers to his 1968 text on educational psychology.

Barnes and Clawson (1975) were less generous. They reviewed 32 studies using a "voting technique" to organize them into groups according to whether the results were statistically significant or not. Non-significant results prevailed 20 to 12 leading the investigators to a negative conclusion. It should be noted that Barnes and Clawson did not separate the results according to the various types of organizers used. Thus, for example, the first study of "structured organizers" (Estes, Mills & Barron, 1969) was included even though these are not true advance organizers. They did, however, differentiate amongst the studies according to length of study, ability and subject type. In each case, the count favored non-significance.

Mayer (1979a), refuted the Barnes and Clawson review, criticizing it on three points: that it was not sufficiently sensitive to Ausubel's theory, that it did not analyze the studies in sufficient detail and that it did not adequately discuss methodological problems in the studies. He then reinterpreted Ausubel's subsumption theory in terms of his own assimilation encoding theory and reported a series of nine studies supporting his contention. Assimilation encoding theory, a three-stage model of learning, posited that:

1. information is received into working memory,
2. that anchoring knowledge must be available in long-term memory and
3. that this anchoring knowledge must be transferred to working memory so that it can

be actively integrated with the received information.

The theory predicts that the organizer will facilitate both the transfer of anchoring knowledge to working memory and its active integration with the received information. It also predicts that the advance organizer may have no effect: if the content and instructional procedure already contains the needed prerequisite concepts, if the content and instructional procedure are sufficiently well-structured to elicit the prerequisite concepts from the learner, or if the organizer does not encourage the learner to actively integrate the new information. Further, if the learner already possesses a rich set of relevant past experiences and knowledge and has developed a strategy for using it, the advance organizer would not be effective (for example, a high ability learner).

Thus, Mayer offered the following advice for constructing advance organizers: it should contain the following characteristics:

1. "Short set of verbal *or visual* [my emphasis] information,
2. Presented prior to learning a larger body of to-be-learned information,
3. Containing no specific content from the to-be-learned information,
4. Providing a means of generating the logical relationships among the elements in the to-be-learned information,
5. Influencing the learner's encoding process".

In his own review of the advance organizer literature, Mayer (1979b) reiterated his position, noting that certain conditions must be met if advance organizers are to have an effect. The conditions are that the material must be unfamiliar to the learner and must be potentially meaningful. The advance organizer must provide or locate the meaningful context and must encourage the learner to use that context during learning. The learner must not already possess the relevant conceptual context for the material nor a strategy for using it (advance organizers should favor low ability learners). And finally, the test of learning should measure *breadth of learning* (transfer and long-term retention).

Using only published studies which contained either an advance organizer group and a control group or a post organizer group, he developed a question-based voting technique for 27 studies. In the cases where there was no control group, post organizers could function in that capacity since they were given after the lesson and were therefore not a form of advance organizer. For each study, he attempted to answer the following three questions: (1) Is the material unfamiliar, technical or lacking a basic assimilative context? (2) Is the advance organizer likely to serve as an assimilative context? (3) Does the advance organizer perform better than the control group on a test? Mayer lists the results as percentages and for only three studies does he claim statistical significance. He concluded that when the advance organizer was used, there was usually a small but consistent advantage for the advance organizer group. He also concluded that advance organizers more strongly aided performance when material was poorly integrated, that they more strongly aided inexperienced learners and that they aided far transfer more than specific retention of details.

Reviews of the advance organizer research use a variety of techniques from the traditional summary (Hartley & Davies, 1976), an either/or voting technique (Barnes & Clawson, 1975), to a question-based voting technique (Mayer, 1979b). Each of these is judgmental and not entirely convincing, although Mayer's review is based on theory. Two later reviews, however, use the more recent quantitative approach of meta-analysis. Of the meta-analytic techniques, the most cited is Glass' (e.g. Glass, McGaw and Smith, 1981) effect size statistic (E.S.) which allows the comparison of studies which vary in design, sample selection and setting in order to form conclusions.

The first meta-analysis (see Table 1), by Luiten, Ames and Ackerson (1980), examined 135 studies yielding 110 E.S. for learning (posttest within 24 hours of the treatment) and 50 E.S. for retention (posttest 24 hours and after). They calculated a mean E.S. of .21 for learning, which would indicate that the average subject receiving the advance organizer treatment would perform better than 58% of the control group individuals. The mean E.S. for retention was .26. Their conclusion was that advance organizers had a small, facilitative effect upon both learning and retention. The effect on learning runs contrary to Mayer's predictions based on assimilation encoding theory as well as Ausubel's subsumption theory. Luiten et al also found advance organizers effective for all ability levels but especially for high ability learners (a mean E.S. of .23) which also contradicts both Ausubel and Mayer.

The second meta-analysis (see Table 1), by Stone (1984), closely followed Mayer's model in order to compare results with assimilation encoding theory. Consequently, she included only studies with a control group or a post organizer and with a posttest administered one week or later after the treatment. She listed 112 different E.S. from 29 studies. Stone reported an overall mean effect size of .66 which indicates that advance organizers facilitate the long term retention of new, unfamiliar material. However, she also compared "true" advance organizers, those which acted as subsumers (more general or abstract) to those advance organizers which were at the same level of generality or inclusiveness as the material-to-be-learned. The mean E.S. for the former was .65 while the mean for the latter was .71. Stone also found lower E.S. for written and abstract organizers than for non-written (illustrative) and for concrete organizers. These results contradict a number of the assumptions of assimilation encoding theory indicated above and provide some support for the use of graphic organizers (to be considered next). Finally, Stone found no special facilitation for low ability or low knowledge learners, again contradicting assimilation encoding theory and subsumption theory.

Table 1. A Comparison of the Luiten et al and Stone Meta-analyses

Variable	**Luiten et al**	**Stone**
learning	0.21	—
retention	0.26	0.66
low ability	0.13	0.26
medium ability	0.08	0.64
high ability	0.23	0.34
Review	**Learning**	**Retention**
Luiten et al	110 E.S.	112 E.S.
Stone	—	50 E.S.

A comparison of several more recent studies (1984 - 1990) of the use of advance organizers reflect the same inconsistent results. One study, reflecting different theory, will be considered separately. The others will be summarized by effect size (see Table 3) and briefly described. The first study (see Table 2) by Corkill et al (1988) consisted of six experiments to investigate retrieval context set theory. This theory holds that re-reading advance organizers before the post-test will aid retrieval of the information from long-term into working memory. Five used the same materials in a laboratory setting with undergraduate university students participating for credit. Only the time of the post-test varied. The fourth experiment was conducted in a university laboratory school with grade seven students using different materials. Their results produce an average effect size of 1.47 for those receiving an advance organizer before the treatment but not prior to the test (no cue condition) and a mean E.S. of 2.54 for those rereading the advance organizer before the test (cue condition).

The treatment for experiment 6 differed in several respects. Subjects were assigned to one of five groups: a "true organizer" (written according to Ausubel's guidelines) group which paraphrased the organizer (cue condition), true organizer/paraphrase (no cue condition), true organizer/paraphrase first paragraph only (cue condition), a "false organizer" (unrelated material) group (cue condition) and a control group. As can be seen in Table 2, in all "true" advance organizer groups, a positive effect was demonstrated while the "false" organizer had a slightly negative effect. The results provide evidence to support the use of advance organizers both according to the theories of Ausubel and Mayer (encoding context) and for retrieval context theory.

The other studies attempted to use advance organizers according to the prescriptions of Ausubel or Mayer. Thus, another study by Corkhill, Bruning and Glover (1988) produced less conclusive results.

Table 2. Corkhill et al. (Retrieval Context)

Experiment	**Cue**	**No Cue**
Expt.1 (Organizer/Paraphrase)	1.04	0.71
Expt.1 (Organizer/Key Word)	0.57	-0.13
Expt.2 (Organizer/Paraphrase)	No control	
Expt.3 (After 1 week)	2.56	1.96
Expt.4 (After 24 hours)	4.93	2.85
Expt.5 (After 2 weeks)	3.78	1.91
Expt.6 (After 24 hours)	3.87	1.53
Expt.6 (Organizer/1st Paragraph)	1.45	—
Expt.6 (False Organizer)	-0.11	—
Mean	**2.54**	**1.47**

In two experiments, they compared the relative effects of concrete (comparative - using an analogy) and abstract (expository) advance organizers on students' recall of prose. Both were laboratory studies carried out with undergraduate university students volunteering for credit. The abstract organizer treatments produced a mean effect size of -.62 while the concrete organizer treatments had a mean effect size of 2.25. These results are somewhat conflicting in that they provide support for comparative but not expository advance organizers, yet both should be effective according to Ausubel and Mayer.

A study by Lenz, Alley and Schumaker (1986) investigated the effects of a regular teacher's delivery of an advance organizer prior to each lesson on Learning Disabled (LD) students' retention and expression of information from a given lesson. Teachers were trained to write advance organizers and the students to make notes on them. Student learning was assessed by an after-class interview in which was recorded the number of statements by the student related to the lesson in which the organizer was used. Results indicated improvement both after teacher training and again after student training. The first improvement can be attributed to the use of the advance organizer per se and conflicts with Mayer's theory which indicates that it should *not* be effective for immediate recall. The student training result could be ascribed as much to the generative activity of note-taking as to the advance organizer.

Kloster and Winne (1989) attempted to define and write advance organizers based upon assimilation encoding theory. Thus, a "concept" (expository) organizer was written at a higher and more inclusive level than the material-to-be-learned and an "analogy" (comparative) organizer was congruent to (but different than) the new material. This study was conducted with 227 students from all eighth grade mathematics classes in a regular high school.

A mean E.S. of -.13 was obtained for the concept advance organizer and 0.06 for abstract advance organizer. Based on effect size calculations, this study indicates a slightly negative effect .for advance organizers. The investigators did, however, note some evidence using trace analysis to indicate that advance organizers increased achievement slightly.

Table 3. Recent Advance Organizer Studies

Study	Learning	Retention
Corkhill, Bruning & Glover (1988)		
Comparative Organizer	-0.05	—
Expository Organizer	-0.27	—
Lenz, Alley & Schumaker (1986)		
Students 1-4 (Teach. training)	1.09	—
Students 1-4 (Stud. training)	3.49	—
Students 5-7 (Teach. training)	0.97	—
Students 5-7 (Stud. training)	2.36	—
Kloster & Winne (1989)		
Comparative Organizer	—	-0.13
Expository Organizer	—	0.06
Gilles (1984)	0.015	0.33
Doyle (1986)	0.74	1.03
Tajika, Taniguchi, Yamamoto & Mayer (1988)		
Fragmented Pictorial	0.078	1.485
Integrated Pictorial	2.04	4.08
Mean	0.426	1.143

Studies by Gilles (1984) with baccalaureate level medical surgical nursing content and Doyle (1986) with remedial college mathematics indicated advance organizers affected both learning and retention with stronger support for the latter, thus supporting assimilation encoding theory. Finally, a recent study (Tajika, Taniguchi, Yamamoto and Mayer, 1988) using a pictorial advance organizers with fifth grade Japanese mathematics produced similar, though stronger, results.

Overall, based on the reviews and recent studies discussed, the evidence does appear to support the contention that advance organizers have a facilitative effect upon learning and retention. This effect is clearly quite variable, however, reflecting the lack of clarity of what an advance organizer is and the difficulty in constructing one. What, then, of the other variations on the advance organizer concept? The next section extends this discussion to include two of its progeny: the structured overview form of advance organizer and the pictorial graphic organizer.

Graphic Organizers

Structured Overviews. As noted previously, the structured overview graphic organizer was originally developed as a modification of the advance organizer and was thought to assume those properties because it attempted to relate new information to relevant subsuming concepts. However, the structured overview differs from the advance organizer in that it has a graphic form (a tree-structure diagram) and is written at the same level as the material-to-be-learned. Given these differences, the question then arises whether this form of organizer affects learning or retention.

A meta-analysis by Moore and Readance (1984) analyzed 23 graphic organizer studies with 161 calculated effect sizes. They reported an average effect size of .22. Upon further analysis, however, they noted an average effect size of .57 for graphic post organizers and indicated that these tended to be constructed either by the instructor with the class or by the student. They concluded that the structured overview form of graphic organizer does have an effect, especially for university students, that vocabulary learning is most positively affected and that post-organizers benefit learners more than advance organizers.

Again, more recent studies appear to support these conclusions (See Table 4). Alvermann (1981), in a study not included in the Moore and Readance meta-analysis, found that partially complete advance graphic organizers had an effect on ninth grade students' comprehension and retention of text. The results indicated the strongest effect for the less well organized text as predicted by assimilation encoding theory. Two studies by Boothby and Alvermann (Boothby & Alvermann, 1984, Alvermann & Boothby, 1986) found the graphic organizer to be effective as a strategy for facilitating fourth graders comprehension and retention of social studies text. While the second (1986) study did not test for retention, it did indicate that graphic organizers had an effect on a transfer of learning task - again predicted by Mayer's theory.

Bean et al. (1986) reported a study in which tenth grade world history students were divided into three groups: one provided with 14 weeks summarization training and taught to construct post graphic organizers, another taught the graphic organizer technique without summarization training and a third taught outlining instead. A series of six multiple choice quizzes indicated a small effect for combined organizer and summary training group but a negative effect for the organizer only group. The sixth quiz alone showed significantly higher scores *for the group with summarization and graphic organizer training (only),* perhaps showing evidence of a generative effect by the summarization training.

Finally, Carr and Mazur-Stewart (1988) found that a vocabulary overview guide (a multi-page booklet) which included a graphic organizer was significantly superior to a traditional form of instruction in improving the vocabulary comprehension and retention of community and technical college students.

Table 4. Recent Structured Overview Studies

Study	Learning	Retention
Alvermann (1981)		
Descriptive Passage	1.26	1.76
Comparative Passage	0.06	0.41
Boothby & Alvermann (1984)	0.98	0.99
Alvermann & Boothby (1986)		
Passage 1	-0.34	—
Passage 2	0.45	—
End of chapter test	0.41	—
Bean et al. (1986)		
Organizer and Summary Training	0.16	—
Organizer Only	-0.11	—
Carr and Mazur-Stewart (1988)	0.89	1.23
Mean	0.42	1.10

While not extensive, the results of these studies are evidence that the structured overview form of graphic organizer, especially the post organizer type, does affect learning. Given these results, one must also ask if there is an effect for the pictorial form of graphic organizer. This question will be addressed next.

Pictorial Graphic Organizers. This organizer can be described as more pictorial, visual or graphic than other kinds of organizers and has two forms: the final form (completed) graphic organizer and the participatory form (to be filled out by the learner during or after the lesson).

A review of the relevant research by Hawk, McLeod and Jonassen (1985) and three more recent studies are reported in Table 5. Two experiments by Jonassen and Hawk tested the use of teacher-constructed participatory pictorial graphic organizers in regular classrooms (grade eight history, grade twelve English literature). The results indicated a stronger effect for learning than for retention. A third study of eleventh and twelfth grade economics/sociology was also carried out but produced no significant results nor was sufficient data available to calculate effect sizes.

Two studies, by Hawk, McLeod and Jeane (1981) and Hawk and Jeanne (1983) were reported in Hawk, McLeod and Jonassen (1985). Statistically significant results indicated that participatory pictorial graphic organizers facilitated both learning and retention. Again, insufficient data was available to calculate effect sizes. A more recent study by Hawk (1986) also found this technique to be effective in facilitating retention for above average students studying life science in the sixth and seventh grades.

Darch, Carnine and Kameenui (1986) compared several techniques for informing six grade reading students of content information, including the cooperative (group) and individual completion of participatory pictorial graphic organizers, to a more traditional directed reading approach. The graphic organizers, especially for the cooperative learning approach, were found to be more effective in facilitating retention than the traditional approach. Immediate recall was not tested.

Table 5. Pictorial Graphic Organizer Studies

Study	Learning	Retention
Jonassen and Hawk (1984)		
Experiment 1	1.10	0.63
Experiment 2	1.74	0.73
Hawk (1986)	—	0.64
Darch, Carnine and Kameenui (1986)		
Cooperative Graphic Organizer	—	1.59
Individual Graphic Organizer	—	0.72
Alvermann (1988)		
Self-perceived High Ability	-0.64	—
Self-perceived Low Ability	3.94	—
Mean	1.54	0.86

Finally, Alvermann (1988) investigated the effects of a final form graphic organizer designed to induce tenth grade social studies students to look back in their texts for missed information. The organizer facilitated learning with low ability students but appeared to interfere with the learning of high ability students, an effect predicted by assimilation encoding theory.

The evidence reported in these studies to support the use of pictorial graphic organizers, albeit meager, is consistently positive. Pictorial graphic organizers appear to facilitate the learning and retention of information, at least for younger learners. Immediate recall, though, appears to have been more consistently affected than longer-term retention of information. Like the two other organizer forms discussed, pictorial graphic organizers, in the participatory form, at least, do appear to be useful.

Organizers In Computer-Based Interactive Video

The second question to be answered by this review was whether or not instructional organizers effect learning when applied to instruction delivered by CBIV. The preceding discussion has suggested that, in general, there is modest, if conflicting, evidence that instructional organizers do have some effect generally. While some of the studies reviewed did use visual and oral versions, the vast majority presented a text form of advance organizers. Mayer's characteristics, however, indicated the acceptability of visual organizers, and so, it appears to be a reasonable leap of faith to presume that they might function in a computer-based instruction format and, particularly, computer-based interactive video, a technology which effectively combines both text and visuals. This, of course, presumes that the medium makes a difference. This continues to be a point of dispute among educational technologists. Clark and Sugrue (1988), for instance, point to decades of few robust differences in learning from different media. They liken media to delivery vehicles and claim that it is the method and not the medium that influences the psychological process that produce learning. Others take a different view. Hannafin (1989) notes a metamorphosis of computer-based instruction in the past decade which has provided educational technologists with "unparalleled tools for manipulating instructional strategies" (p.167). He sees the increased potential for interaction as the fundamental difference between traditional and emerging technologies [such as CBIV]. While he agrees that the method is important, that educational technologists should be "concerned with the manner in which instruction fosters cognitive engagement...", he claims that such engagement is mediated by a number of factors including the nature of the presentation stimuli (p.170). The use of instructional organizers represent various possible methods of fostering cognitive engagement. Will they do so when used in interactive instruction?

Unfortunately, there appears to be little evidence as of yet to support the use of either advance or graphic organizers in a such environment, although Hawk, McLeod and Jonassen (1985) offer some advice for the design and preparation of pictorial graphic organizers (of either type) for electronic text. Hannafin and his associates appear to have done the bulk of such research and have published a series of papers (e.g. Hannafin, 1987, Hannafin and Hughes, 1986, Hannafin, Phillips, Rieber, and Garhart, 1987) on "orienting activities" in CBIV based on the ROPES+ (Retrieval, Orientation, Presentation, Encoding and Sequencing, "+" the influence of contextual factors) meta-model for designing instructional prescription (e.g. Hannafin and Rieber, 1989). The "O" in ROPES refers to "Orienting" activities. An orienting activity acts as "a mediator through which new information is presented to the learner" (Hannafin and Hughes, 1986, pg.239). They include advance organizers (including the various graphic organizers) in their category of orienting activity indicating that they are "a variation of cognitive orienting ability" (Hannafin, 1987, p.48).

Hannafin and Hughes (1986) used both a video advance organizer and a final form graphic organizer in the development of a prototype CBIV lesson on rocketry for aerospace engineering students but reported no data. In a study on the effect of orienting activities in computer-based instruction (CBI) which used upper class undergraduate and graduate university students, they found that both behavioral and cognitive orienting activities improved factual learning. Their description of the cognitive orienting activity was: "designed to provide an integrative method for establishing meaningful relationships, while also serving as a subsumer of lesson detail" (Hannafin, Phillips, Rieber and Garhart, 1987, p.80). This sounds like an advance organizer. However, the one example they give, "In the next section, you will be presented information about: The importance of studying cultures." (p.77), seems insufficient according to Mayer's characteristics.

Similarly, Hannafin, Phillips and Tripp (1986) used a one sentence cognitive orienting activity in a CBIV lesson on artists and art periods with 80 volunteer college students (graduate and undergraduate). They noted a significant interaction between the orienting activity and processing time but no main effect. Another study (Hannafin, 1987) compared the effects of orienting activities, cuing and practice on the learning of material on space voyages by ninth grade students. A significant interaction was found between the cognitive orienting activity and practice but the orienting activity alone was not demonstrated to be a significant instructional component. Again, the example of the cognitive orienting activity provided, "The Next Section Presents the Following Concepts: ===> Unique lighting found throughout the solar system (and) ===> Matter found throughout the solar system", also seems meager.

Rieber and Hannafin (1988) also studied the effects of textual and animated cognitive orienting activities on learning from CBI. Their subjects were 111 fourth, fifth and sixth grade students from a rural elementary school who were presented a lesson describing and explaining Newton's laws of motion. The orienting activities were of one minute duration each and consisted of either a text only, one sentence summary of the particular basic concept, an animated graphic sequence or a text and graphic sequence. There was also a control (no activity) group. The orienting activities were presented throughout the lesson before each basic concept. They found no statistically significant effects for any of the orienting activities.

The orienting activities in these studies meet three of Mayer's characteristics for advance organizer construction: (1) a short set of verbal or visual information, (2) presented prior to the material-to-be-learned and (3) containing no specific content from that material. However, one could reasonably argue as well that, for none of these studies, were the cognitive orienting activities of sufficient scope to meet the other two conditions; that is, (4) generate logical relationships among elements in the to-be-learned material or (5) to sufficiently influence the learner's encoding process. The organizing activities used in these studies were not true advance organizers.

One study which did present "true" advance organizers was carried out by Carves, Lindbeck and Griffin using a computer-based tutorial on kinematics with 100 suburban high school physics students. The advance organizers were "written according to the guidelines of Ausubel et al (1978)" (p.785) and were presented on screen. There was no significant difference between the groups advance organizer treatment and a non organizer group (which read a related passage designed not to act as a subsumer). Krahn and Blanchaer (1986), however, tested the use of a "true" advance organizer to improve knowledge application by medical students in a computer-based simulation. Post-test scores showed a statistically significant difference between the experimental and control group, both for the total scores and particular questions designed to test far transfer, as predicted by assimilation encoding theory. The test, however, was given immediately after completion of the simulation and consisted of only six questions. No validity or reliability data were provided.

Based on the results of these studies, there appears to be no convincing evidence yet to suggest that any of advance organizers, structured overview graphic organizers or pictorial graphic organizers would be effective if incorporated in instruction based on CBIV.

Discussion

Advance organizers were, of course, developed from Ausubel's theories about meaningful verbal learning while Mayer analyzed the research in terms of assimilation encoding theory. Corkhill et al tested the construct of advance organizers in the context of Retrieval Theory. All were cognitive learning theories advanced to explain aspects of learning. Each theory posits that advance organizers would have a covert, internal effect on how the learner encoded the information presented.

It is interesting to note, however, that pictorial graphic organizers and structural overview graphic organizers both appear to be most effective if presented in participatory form; that is, to be filled in or constructed by the learner. This may be the case, Hawk, McLeod and Jonassen (1985) point out, because "the more generative the nature of student participation, the more likely it is that transfer and higher level learning will be affected" (p.179). They are referring here to yet another cognitive learning theory with different implications.

This cognitive theory was developed by Wittrock (1974- who termed it the generative$learning hypothesis. Wittrock states that "it is the learner's interpretation of and processing of the stimuli, not their [the stimuli] nominal characteristics, which is primary" (p.88). In more simple terms, learners must construct their own meaning from teaching (Wittrock, 1985). Doctorow, Wittrock and Marks (1978), in a further commentary on generative processes, indicated that it involves not only generating meaning but overt activities (generating associations among words, generating pictures, etc.) as well.

In a comparison of Wittrock's hypothesis to another cognitive theory, Rothkopf's concept of "mathemagenic" activities, Jonassen (1985) differentiated between the two orientations. One, which he labelled "constructive mathemagenic", accepts "that certain design attributes of any medium give rise to learning (because) the form or structure of the display induces the necessary cognitive processes to produce learning" (p.9). The other, which he labelled "constructive generative", adheres to the belief that "what gets learned is more a function of the mental processes in which the learner engages then any attribute of the text display, because learning is a *generative* process - an act of constructing knowledge"(p.10).

There is some question (e.g. Grabowski, 1989, Stewart, 1989) whether or not Jonassen is correctly interpreting Rothkopf's definition of mathemagenic behaviors. However, there is a distinction to be made between learning activities which require covert activity on the part of the learner and those which require an active response. While rejecting the label of mathemagenic, Stewart (1989), in his discussion of instructional text, accepts that there is a dichotomy. He labels the former "adjunct aids" instead. These adjunct aids include advance organizers, graphic organizers, adjunct questions and learning objectives. Jonassen (1985) lists several aids to text as "constructive mathemagenic", including adjunct questions, overviews and organizers. "Constructive generative" techniques, on the other hand, include such techniques as outlining, mapping and pattern-noting (p.16).

"True" advance organizers therefore are not generative. They elicit a covert response, rather than overt, active learning on the part of the learner. It is only the participatory form of the pictorial graphic organizer advanced by Hawk, McLeod and Jonassen and the student-constructed form of structured overview that are generative. Perhaps this explains the morass of equivocal results particularly from advance organizer research. Given the difficulty in determining exactly how to construct them, it may be that some investigators unknowingly designed their organizers such that the learners engaged in generative learning activities. Future investigation of instructional organizers might focus on the generative learning hypothesis, to determine if indeed the problem with advance organizers and the more static forms of graphic organizer is not a matter of definition but of approach.

Recommendations for Future Research on Organizers in CBIV

As has been seen, the research pertaining to the use of organizers, whether advance or graphic, in CBIV has not been extensive. Most has been carried out under the umbrella of the ROPES+ meta-model by Hannafin and associates. While they include advance organizers and graphic organizers in their model, it is doubtful that the cognitive orienting activities they have used represented forms of these techniques. The lack of effect is not surprising, especially considering the modest results reported in past research.

Based on this review, it is evident that three areas show much promise for future research. These include: better designed organizers used with CBIV, interactive graphic organizers and organizers based on generative learning. Each will discussed in turn.

The first suggestion for research is that if advance organizers are to facilitate instruction presented via this medium, their design needs to be more thorough; that is, constructed according to Mayer's characteristics. As well, the medium of CBIV, with the potential for offering both computer graphics and video sequences, seems to be tailor - made for exploring the use of non - written advance organizers and the various styles of graphic organizers. Hawk, McLeod and Jonassen (1985) note, for instance, that pictorial graphic organizers could be provided in either print version or on screen.

A second suggestion is that the research on screen graphics (e.g. Grabinger and Albers, 1988, Siliauskus, 1986), on diagrams (e.g. Winn and Holiday, 1985) and on hypertext tools such as the *Learning Tool* (Kozma, 1989) and *Notecards* (McAleese, 1988) be applied to the development of effective electronic displays of pictorial graphic organizers with which the learner can interact; that is, fill in or modify.

The final recommendation relates to the discussion on generative learning. It seems reasonable to suggest that research on generative learning may help fill in the gaps, to explain the limited and varied effectiveness of instructional organizers. Some of the most impressive results were garnered when students were actively engaged in the learning process; for example, generating questions about the material being studied, constructing their own organizers or filling in graphic organizers. It may be that subsumption theory and assimilation encoding theory are indeed predictive of learning but only account for a limited depth of processing. Indeed, even Mayer (1984) reported evidence for the use of elaboration activities (behavior by the reader aimed at relating the presented material to existing knowledge) and concluded they help build external connections. Perhaps then, only when learning is generative, will students make effective use of techniques such as instructional organizers to truly understand and remember. The power of CBIV, with its flexibility, its potential for interactive learning and its capability for tracking the choices made by the learner, should be able to provide a strong contribution to the investigation of these questions.

In summary, this paper sought to synthesize what research evidence reveals about the effect of instructional organizers, including advance organizers, structured overview graphic organizers and pictorial graphic organizers, on learning and retention. It further sought to determine what effect, if any, such techniques might have when applied to instruction delivered by computer-based interactive video, a promising, interactive medium. The results suggest that each technique may have a modest, if variable, effect across a broad range of learners and subject matter. Predictions from the models of Ausubel and Mayer were not consistently confirmed. Modifications to these models, or the consideration of different theory, may be needed to account for these effects.

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DIGITAL VIDEO INTERACTIVE: WHAT MULTIMEDIA DEVELOPERS THINK ABOUT IT

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Abstract

The Digital Video Interactive (DVI) Project at Virginia Tech, Blacksburg VA, is one of only a few university groups working in this exciting new multimedia field. To advance our knowledge of the technology, we conducted a survey of other DVI development sites. These sites were producing DVI-based applications ranging from point of information, to proof of concept, to commercial ventures. Our survey focused on five main topics pertinent to DVI application development, including what DVI-based application was being developed, how it was done, problems encountered, development tools, and general impressions. This article documents responses of the interviewees as well as reports results common among interviews. It deals with questions of DVI application feasibility, cost effectiveness, and requirements through the experiences of persons knowledgeable in this area—DVI developers themselves.

Introduction

A research project between Virginia Tech and NCR, initiated in May 1989, has as a goal exploring the future of Digital Video Interaction (DVI) application development. DVI™—Digital Video Interactive—is a new technology from Intel Corporation for developing and presenting multimedia applications in a completely digital format. Such multimedia applications combine audio, still images, and motion video with text, graphics, and animation, and—most importantly—allow real-time manipulation of any of these by a user. This real-time interaction is possible because all media are digitally captured and stored on a random access device (e.g., hard disk or CD-ROM). DVI can support 72 minutes of full-screen, full-motion video and audio from a single compact disc.

A DVI development system currently consists of a PRO 750 Application Development Platform hosted on an IBM PC/AT-compatible computer with three special boards to support DVI: a video board containing the Intel video display processors; an audio board with a digital signal processor that provides multi-track, multi-channel digital audio; and a utility board with a CD-ROM interface. A DVI system also has an RGB monitor, an audio amplifier and speakers, and a standard Sony CD-ROM drive, as well as add-on VRAM modules, video and audio digitizer modules, 40 megabytes and large capacity magnetic discs, and run-time system software. Capture and playback of all multimedia components are supported by proprietary compression and real-time decompression techniques.

Our project has developed some DVI applications, from which we have learned much about the current state of the technology, its strengths and weaknesses, and its potential for commercial success. However, in order to further advance our assessment of the technology, we conducted a survey of other DVI development sites during the summer and fall of 1989. Because of the newness of DVI technology, little was known at that time about the kinds of applications that were being developed on a DVI platform, the appropriateness of DVI as a development platform for these applications, the pros and cons of DVI development, and so on.

Our survey focused on five main topics pertinent to DVI application development:

1. what DVI-based application was being developed,
2. how it was done,
3. problems encountered,
4. development tools, and
5. general impressions.

Most of the interviewees were application developers, but some were managers or project leaders. The kinds of projects being developed included point of information, proof of concept, and commercial ventures.

The purpose of our survey was three-fold:

- to establish a communications link between our project and other DVI development sites;
- to learn first hand from the experiences of other development efforts, including the problems encountered and the methodology involved; and
- to provide input for a multimedia taxonomy and a multimedia development tools requirements document that we are also producing.

This article documents responses of the interviewees as well as reports results common among interviews. It deals with questions of DVI application feasibility, cost effectiveness, and requirements through the experiences of persons knowledgeable in this area—DVI developers themselves.

Methods

We developed a structured interview to be administered to DVI developers. All interviewees responded to the same set of questions. The interview was divided into two parts:

- *interviewee demographics*—questions about background both in DVI and non-DVI technologies, and

- *DVI-related information*—questions related directly to each of the five topics listed above.

Each interviewee was contacted to schedule an appointment for their interview, which took about an hour and a half to complete. Most interviews were conducted by phone, with the interviewer reading questions from the interview form and recording answers as the interviewee responded. A few interviews were done in person and, in one case, the interview form was filled out directly by the interviewee. In all, ten interviews were completed, by persons at nine different organizations. The questions were aimed mainly at developers, but were appropriately rephrased to accommodate interviews with managerial personnel.

The interviewee selection process was based upon availability and willingness to do the interview. Through our survey we wished not to collect information from any particular development site, but rather to collect information from any site with significant DVI experience. Many of the persons interviewed were either previously known to us (e.g., from conferences, meetings, or other contacts) or were suggested through personal references.

Results

Interviewees' Background Demographics. Table 1 displays interviewee demographics. It shows that the majority of those interviewed were technical programmers or software engineers with approximately one year's experience with DVI-related work. Several interviewees were either managers within or presidents of their company. Two had been involved with DVI since 1984, when RCA was owned the technology. Most interviewed had some prior work with Interactive Video Disk (IVD) technology, indicating a natural transition to DVI work. Of the developers, some had a Bachelor of Science degree in computer science, some had advanced degrees, while others had only a minor in computer science.

Organization	Title	Education	DVI Experience	DVI Training	Related Experience
Andersen Consulting, Dallas TX	Senior Systems Analyst	BS in Computer Science	18 months	Intel 2 day workshop	CD-ROM
Applied Optical Media Corp., Malvern PA	President	MBA	18 months	Intel 2 day workshop	IVD
CBIS, Atlanta GA	Director of Product Development	MS in Communications	9 months	None	None
General Dynamics, Groton CT	Software Engineer	BS in Computer Science	18 months	Intel 2 day workshop	CD-ROM, IVD
Horizons Technology, Inc., San Diego CA	Software Engineer	MS in Geography, Minor in Computer Science	3 months	Intel 4 day workshop	Graphics, image processing
Interactive Media Center, Ithaca NY	Senior Programmer	BS in Liberal Arts, Minor in Computer Science	6 months	Intel 2 day workshop	Graphics, IVD
Software Engineering Institute, Pittsburgh PA	Software Engineer	MS in Computer Science	12 months	Intel 2 day workshop	Graphics, IVD
Virginia Tech, Blacksburg VA	Graduate Student	MS in Computer Science	6 months	Intel 2 day workshop	Graphics
Videodisc Publishing, Inc., New York NY	Project Manager	BA in Communications	since 1984	No formal	IVD
Videodisc Publishing, Inc., New York NY	President	Unknown	since 1984	No formal	IVD

Table 1. Demographics of Interviewees

DVI-Related Information. Information in this section of the interview constituted the major portion of the interview, and was structured around the five topics listed above.

1. What DVI-based application was being developed.
Most of the DVI applications were being developed as prototypes—either proof of concept or point of information projects; however, three of the applications were intended for commercial ventures. Table 2 shows classification of the projects as commercial or experimental and the title/purpose of the project.. In the year since our interview was conducted, some of these applications have come to fruition, while others have been abandoned.

2. How it was done.
The tasks involved in the development phase of the DVI applications varied from project to project. The more ambitious projects, especially those producing a commercial product, tended to follow a typical software development life cycle: planning, design, prototyping, implementation,' testing, and revision. In addition, most of the DVI sites also included two additional tasks in the development process: taking time to learn the hardware and software; and planning, preparing, and organizing source materials to put on CD-ROM. Some of the sites did not engage in much planning or design because they were not intending to produce a specific product, but rather were attempting only to learn more about DVI technology.

The hardware and software used for development were fairly consistent among projects. Most were using the standard Intel PRO 750 personal computer with appropriate DVI boards and 4 Megabytes RAM, a hard drive (various capacity), Sony color monitor, mouse, MS-DOS, Microsoft C 5.1 compiler and linker, and Intel DVI run-time application software. Some sites were also using a Sony CD-ROM drive and extended memory system (EMS). Many of the sites originally started their development using a Dell System 310, but switched to the PRO 750 after Intel changed hardware support.

3. Problems encountered.
There were many problems encountered by all the DVI application development sites. The main problem that permeated through all the interviews was insufficient software documentation and product support. The development process at all sites was considerably hampered by inadequate documentation that lacked examples meaningful to basic DVI functionality.

ORGANIZATION	EXPERIMENTAL	COMMERCIAL
Andersen Consulting		"Process Analyst Workbench" Uses ELV to analyze efficiency for training employees
Applied Optical Media		"Truck Driver Safety" Training program for drivers to increase road safety
CBIS		Not an application; developing authoring tool for DVI possibly on a high-speed network
General Dynamics	"Submarine Surrogate Travel" Interactive navigation through interior of submarine	
Horizons Technology	"Aircraft Video Textbook" Demonstrates mechanical work on an aircraft	
Interactive Media Center	"Spanish Airplane" Interactive educational tool for students	
Software Engineering Institute	"Code Inspection Simulation" Combines expert system and DVI to aid software code inspections	
Virginia Tech	"NCR Product Theater" Displays NCR product information to demonstrate DVI capabilities	
Videodisc Publishing		"Design and Decorate" Facilitates interior design work using changeable fabrics, forms, room layout, etc.

Table 2. DVI Project Classifications

Compounding the problem was the software support availability. Many developers had difficulty getting solutions to problems that were obstructing progress on their programs, because of understaffed support offices and an inefficient bulletin board for contacting support personnel.

Other problems with DVI application development were software-related, but some hardware problems still existed at the time of our interview. Table 3 shows some common hardware and software problems in DVI application development encountered by our interviewees. Developers attributed the underlying causes of these problems mainly to the newness of the technology. They felt that most of the software and hardware problems will be corrected as the technology evolves, as will the problems with documentation and support. In addition, developers also attributed some of the problems to a lack of methodology for DVI development. Most were unaccustomed to the wide range of diverse backgrounds—software engineers, human-computer interface designers, video production specialists, instructional designers, graphic artists, and so on—needed for DVI development, and therefore felt that their methods for developing a future DVI application would change. Lastly, most developers felt that interactive development tools would greatly increase the efficiency of the DVI development process.

4. Development tools.

DVI application programming is an inherently complex process and, without interactive tools, is very slow and cumbersome. Application developers need a set of multimedia development tools to facilitate production of DVI applications. In particular, the need for an interactive tool to alleviate some of the coding needed for basic DVI functions was indicated by many interviewees. The "DVI tools" that currently are supplied with the DVI support software are actually low-level programming support commands that require a detailed understanding of DVI. They do not facilitate application design and are usable only by a person—typically an application programmer—who understands the intricacies of DVI technology. Because of the large number of roles involved in developing a DVI application, the non-programming roles in particular need tool-based support to remove them from the chore of writing source code.

Many of the interviewees had diverse definitions of what a comprehensive tool to support DVI development should be able to do, but most thought that a set of DVI development tools should exhibit several critical capabilities:

- the ability to incorporate basic DVI functions into an application interactively—that is, without writing source (programming) code—and then augment functionality through a high-level programming language;
- a quick way to prototype the DVI application's human-computer interface; and
- usability by non-programmers so that, for instance, graphic design can be done by a graphic designer.

In addition to these capabilities in the development tools, interviewees also indicated that DVI programmers need other basic tools, such as a debugger to support programming efforts, an audio/video data editor, a special effects editor, and so on. These tools are necessary to improve the efficiency of DVI application developers and, ultimately, reduce development costs.

5. General impressions.

This section of the survey investigated each interviewee's impressions of DVI application development, as well as DVI technology in general. In sum, every person interviewed thought that their project was a success.

Software Problems
• Muliple AVSS files with audio streams open simultaneously causes system to crash • Edit Level Video (ELV) not working correctly; causes hard disk failure • Memory fragmentation • Not enough memory available for large-sized application • Unpredictable DVI function calls • Cannot read from hard disk while motion video is paused • Bugs more obscure for DVI application development than for "normal" applications • 256 x 240 graphic resolution when integrated into motion video
Hardware Problems
• Recommended hardware is the only supported hardware • Rapid succession of mouse events causes refresh of mouse pointer to lag behind • Synchronization of audio/video • Color distortion • Board conflicts

Table 3. List of DVI Development Problems

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All said that they accomplished what they had set out to do, whether it was proof of concept, point of information, or a commercial product. When asked to list the good things about developing a DVI application, the responses included:

- flexibility of the DVI environment;
- a digital environment that provides full-motion, full-screen, high quality video; and
- the combination of video, audio, graphics and text into one format and medium.

All interviewees saw DVI as having a potentially huge impact in training, commercial, and educational environments. However, interviewees felt that technical problems, especially the lack of documentation and support, caused most of their delays. At the time of the interview, some interviewees suggested that new DVI projects wait at least six months for the technology to stabilize.

Conclusions

Through our survey results, it is evident that DVI has won approval from its developers as a viable and desirable technology. In particular, the following conclusions were drawn from our interviews:

- Currently, DVI development is very slow and very difficult.
- DVI's greatest deficiency presently is lack of a development environment and trained developers.
- Current DVI hardware and software still need much work, to improve their integration, functionality, usability, and reliability.
- Interactive tools to support DVI development are virtually non-existent (notable exceptions include MediaScript from Network Technology Corporation and Authology: Multimedia from CEIT), and will be difficult to build at a high level; however they are desperately needed.
- DVI development requires a broad variety of skills, some of which are not typically found in traditional software development.
- DVI project management must be done very adaptively.
- DVI has an enthusiastic following; developers will build upon existing low level support, and are anxious to produce a range of products.

In sum, results of our survey of ten DVI developers indicated that DVI has great potential as a multimedia technology, but it needs much more development support in order to be produced in an efficient, cost-effective manner.

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MANAGEMENT ACTIVITIES FOR INTERACTIVE VIDEODISC PROJECTS

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Abstract

Project management is an issue that has been neglected by the instructional system development (ISD) field, especially for newer instructional technology like computer-based interactive videodisc (CBIVD) projects. There is a need for new comers to translate and apply concepts and techniques into the execution of actual tasks in each sophisticated CBIVD project. Integrating the application of various skills needed in developing CBIVD programs demands management sophistication.

This presentation will integrate discussion of management activities from personal experiences and from literature that has been available with the activities required to develop CBIVD projects. A project management activities matrix, suitable for CBIVD, forms the architecture of the presentation. The matrix outlines four management arrays through five project phases, analysis, design, production, implementation, evaluation, will be addressed: planning, controlling, communicating, and documenting arrays.

Introduction

Suppose you are an instructional designer, have already gained lots of knowledge about instructional theories, instructional system development (ISD) models, and instructional design principles, experienced in the design and development of instructional/ training materials, but not in the development of computer-based interactive videodisc (CBIVD) projects. You're in charge of a project to develop a CBIVD training program. The budget and time lines seem pretty tight, but you're not quite sure. You need help to manage this project, but where do you turn? How could you connect the discipline in instructional design (ID) with the real-world in order to execute tasks within a sophisticated IVD project? Or, suppose you have great computer-based management tools in hand, what events or activities should you put into each blank screen and when. To produce a CBIVD instructional system is neither a small nor simple task. For most instructional design/development (ID) people, the search for guidance would be frustrating.

Project management is an issue that has been neglected by the instructional design (ID) field, especially for newer instructional technology like CBIVD. The instructional system design and development (ISD) models available in literature are more conceptually-oriented than *operationally-oriented.* These models do provide strong background on theories and highlight what must be done in the whole ISD processes. But, there is a need for new comers in computer-based interactive video project to translate and apply concepts and techniques into the execution of actual tasks in each CBIVD project. Furthermore, CBIVD projects require the services of a team with sophisticated skills: video production, programming, script writing, graphics design, instructional design, at a minimum. Integrating the application of these skills demands management sophistication. Schiffman (1986) mentioned that "whenever instruction is being designed, all five of the major categories are called into play." These categories are theories, system analysis, diffusion, consulting or interpersonal relations, and project management. In order words, management is an essential component in the ID discipline as well as in application. Unfortunately, while looking through major ISD textbooks we will find out that most of them don't put the management issue into account. Knirk and Gustafson (1986) said that there are five management activities—planning, organizing, coordinating, evaluating, and reporting in managing projects. They do give us a good picture about what management components should be. Nevertheless, they don't support it with detailed events for the readers usage. Because good management could not only facilitate successful accomplishment of project events within plans, but also arouse CBIVD team members' potentials and team productivity, we do need an operational CBIVD management model which covers management activities in detail for each member and is familiar to team members as well as sponsors to serve as a communications framework.

In 1988 and 1989, Greer published a series of ID project management articles for project manager's usage. Greer presented a ID Project Management Model which is divided into three phases and included ten steps: project planning, instructional development, and follow up phases. From the author's point of view, project management is every member's responsibilities rather than the manager's only. Hence, we need a management guideline which covers managing activities for each CBIVD team member and is familiar to members as well as sponsors to serve as a communications framework. An appropriate framework for managing projects should be common ID model instead of inventing any new framework which forces readers to reconstruct their mental models. This article integrates discussion of management activities from personal experiences and from literature that has been available with the activities required to develop CBIVD projects. A project management activities matrix, suitable for interactive videodisc projects, forms the architecture of the presentation. The matrix outlines four management arrays (cf., Figure 1) through five project phases, analysis, design, production, implementation, evaluation, will be addressed: (a) Planning array: to arrange the conditions and prepare plans for project activities; (b) Controlling array: to stimulate, monitor, intervene, criticize, and modify project activities, materials, or products; (c) Communicating array: to deliver communications among team members and outside people; and (d) Documenting array: to document materials or products. Management activities in each array are described in following paragraphs.

Planning To arrange the conditions and prepare plans for project activities	**Controlling** To stimulate, monitor, criticize, and modify project activities
Communicating To deliver communications among team members and outside people	**Documenting** To document materials or products

Figure 1. Four arrays of CBIVD project management

Management Activities

The project management task consists of planning, controlling, communication, and documentation arrays across five common ID phases (Figure 2). The four management arrays and their functions as well as activities are:

Planning. The function of planning is to arrange conditions under which project activities take place and to prepare plans for how, when,a and by whom executing what events where. Planning activities in each phase are:

Analysis Phase. The conclusion of previous problem analysis that instruction by CBIVD was the answer to the problem. The preliminary project plan was approved by sponsors or higher-level authorities.

To refine the preliminary project plan be estimating detailed schedule, cost, as well as task charts. This refining plan process and preparing preliminary plan could be done and revised conveniently by software tools. For instance, MacProject could be used to plan: schedule chart, resources/task/project timetables, and costs. Managers, instructional designers (IDers), programmers, subject matter specialists (SMEs), and design/production artists should be the core group in ID projects.

In order to accomplish the planning process, a manager needs to locate resources and to group the project team. For the purpose of communicating with others and record keeping, the core group should develop format sheets for controlling and communication.

When finish each phase, the manager should deliver the revised materials or products to sponsors or higher-level authorities and gain written approval from them in order to set up operational conditions for the following activities. Finished project plan, ready-to-go project team, and sponsor approval are the outputs.

Design Phase. For arranging the design environment, the core group cooperates to set up facilities, equipment, materials, and media.

In order to control project activities with timetable, team members must prepare operational conditions for the next project phase. During the design phase,the ID team needs to schedule the production process. At production phase, team members should prepare for implementation.
Operational conditions for project design activities, contract with production house, and sponsor's approval are the outputs.

Production Phase. Set up facilities, equipment, materials, and media for production and pilot testing. Arrange subjects and resources for pilot test.

Operational condition for production and evaluation activities, implementation plan, and sponsor's approval are outputs of this phase.

Implementation Phase. Install hardware, software, and videodisc supporting with adjunct materials for implementation usage. Outputs are operational CBIVD courseware systems and sponsor's approval.

Evaluation Phase. Send formative and summative evaluation reports as well as impact evaluation plan to sponsor. Outputs are impact evaluation plan and sponsor's approval.

Controlling. The function of controlling is to stimulate, monitor, intervene project events (for manager); to criticize and modify project activities, materials, as well products; and to record activities during the development processes (for team members). Critiques or formative evaluation should start at the very beginning and go through the whole project. Modification or revision is the action which responds to evaluation results. The controlling function is the same for each phase. The difference is activities or products to be controlled. The following list of activities and products to be controlled could form a basis of checklists. The detail about how to evaluate each activity or product is beyond the purpose of this article.

Activities in Each Phase.
Analysis:

- Gather and analyze data for needs and learner analysis.
- Locate resources, materials, equipment, facilities, media.
- Develop content report.

PLANNING

Analysis	Design	Production	Implementation	Evaluation
Estimate time/budget Group project team Develop project plan Design format sheets Gain sponsor approval	Schedule production process Prepare for production & testing Set up design facilities Gain sponsor approval	Prepare implementation plan Set up production environment Set up pilot test sites Gain sponsor approval	Install courseware, hardware Deliver adjunct materials Gain sponsor approval	Gain sponsor approval Prepare impact evaluation report

CONTROLLING

Analysis	Design	Production	Implementation	Evaluation
Stimulate activities Review/revise materials Take records	Stimulate activities Control activities Revise materials Revise subroutines Take records	Stimulate activities Control activities Revise materials & products Revise courseware Take records	Stimulate activities Control activities Adjust CBIVD systems Take records	Stimulate activities Control project activities Take records

COMMUNICATING

Analysis	Design	Production	Implementation	Evaluation
Conduct meetings Contact outside resources Contact sponsor Informal communication	Conduct meetings Deliver status memos Contact sponsor Informal communication	Interact with production house Conduct meetings Deliver status memos Contact sponsor Informal communication	Interact with implementation sites Conduct meetings Deliver status memos Contact sponsor Informal communication	Interact with users Deliver reports to sponsor Informal communication Conduct reflection meeting

DOCUMENTING

Analysis	Design	Production	Implementation	Evaluation
Needs assessment report Learner profile Content report Budget/schedules Charts/forms Evaluation strategies Communication strategies Resources information Project plan Contracts Sponsor approval records	Treatment description Screen design description Format sheets Scripts Storyboards Flowcharts Subroutine programs Contracts Sponsor approval records Other materials	Graphics Computer programs Video, audio tapes Master videodiscs Integrated courseware Adjunct materials Sponsor approval records Other materials	Copies of software, videodiscs, adjunct materials Sponsor approval Records Other materials	Final reports with formative and summative evaluation Sponsor approval records Other materials

Figure 2. Management Activities for CBIVD projects

Design:

- Conduct treatment & formatting design.
- Design instructional and testing strategies (micro design).

- Write scripts and storyboards.
- Design graphics, program subroutines.

Production:
- Develop graphics and programs in computer.
- Produce and edit video, audio, audio/video tapes.
- Produce 1" master videotapes.
- Produce check videodisc, master videodisc.
- Integrate computer program with videodisc.
- Develop adjunct materials.

Implementation
- Install Implementation system.

Evaluation
- Finish formative and summative evaluation reports.
- Conduct impact evaluation activities.

Products of Each Phase
Analysis:
- Needs assessment report.
- Learner profile.
- Budget, timetables, schedules, task charts.
- Evaluation and communication strategies with format sheets.
- Content reports (task analysis, outlines, objectives, etc.)
- Project plan (project description, schedule, charts, and reports).

Design:
- Treatment and formatting description.
- Instructional algorithms.
- Lesson design and testing strategies.
- written scripts and storyboards with graphics design.
- Program flowcharts and subroutines.

Production:
- Computer graphics, programs and codes.
- Tapes and videodiscs.
- Integrated courseware.
- Adjunct materials.

Implementation:
- Copies of software, videodiscs, adjunct materials.
- CBIVD courseware systems.

Evaluation:
- Final project report.
- Impact evaluation plan.

Communicating. The function for communication is to communicate with each others among team members and outside sponsors, experts, subjects, or other resources by informal and formal communication channels. The formal communicating ways for team members could be (a) by meetings—from the kick-off and brainstorming meeting to the reflection meeting; and (b) by project status memos through the processes. Formal communication between ID team and outside people are: interact with sponsor, higher-level management, producers and applicators, and users. The informal communication may happen at any interpersonal interaction, such as, by telephone, conversation, rumor, personal observation, gestures, or feelings. Any interaction regarding project progressing should be recorded and analyzed.

Documentation. The function of this component is to document every materials, products, or programs (cf., Figure 2) which are developed in planning, controlling, and communicating component.

Conclusions

The appeal of CBIVD, with its myriad opportunities for instructional innovation and creativity, has encouraged ID professionals to push ahead. This presentation offers some suggestions for IDers to clarify and explain the project management process and tries to identify essential management components in CBIVD projects. As we know, no list can be all-inclusive, because every projects is unique while compared with others. Many other activities may be added as projects become more complex and several activities could be moved out when tasks become simpler. However, it the the author's hope that the model provides applicable starting points for readers and handouts delivered in the presentation will be provided in support of the matrix to guide the novice CBIVD project manager during their first experiences with CBIVD development.

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USING AN EXPERT SYSTEM SHELLS AS AN AUTHORING TOOL FOR INTERACTIVE VIDEODISK APPLICATIONS

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Abstract

This paper presents the usage of an expert system shell as an authoring tool for the implementation of interactive videodisc applications. The power of the inference engine combined with informational databases and external program calls make selected expert systems shells excellent authoring tools for videodisc prototyping and implementation. One microcomputer based expert system shell, VP-Expert, is discussed in detail.

Introduction

The purpose of this paper is to explain and document the feasibility of using an expert system shell as the vital authoring tool in microcomputer based videodisc applications. The paper is divided into the following parts:

1. OVERVIEW OF EXPERT SYSTEMS
2. INTEGRATION OF EXPERT SYSTEMS AND LEVEL III VIDEODISK IMPLEMENTATIONS
3. VP-EXPERT AS AN AUTHORING TOOL
4. SUMMARY
5. APPENDIX A: OVERVIEW OF VP-EXPERT

In section one, the interested reader will find a quick overview and definition of terms used in expert systems and intelligent tutoring systems. Section two will focus on the features of an expert system shell that enhance the implementation of interactive video. A technical overview of how the concepts in part two can be implemented with VP-Expert, a microcomputer based expert system shell, is discussed in section three. The next part will summarize the major points of the entire paper, and the appendix will give an overview of VP-Expert.

Overview of Experts Systems

An expert system is a software program that mimics the reasoning ability of some human expert in solving a particular set of problems. The problem or domain area is narrow in scope as opposed to general problem solving. An expert system could give advice on selecting a money market plan, assist an aircraft mechanic on repairing a Boeing 707, diagnose the medication for bone cancer, or generate possible options for vacations in Hawaii.

Expert systems can enhance educational situations. A principal could use an expert system to assist in designing student schedules. A mathematics teacher could utilize an expert system to diagnose and remediate first year algebra problems. An expert system can be integrated with the curriculum to assist in tutoring in a particular area. The potential for using expert systems as an intelligent tutor is a catalyst in educational technology today.

These examples indicate that the purpose of an expert system is to assist in a particular domain of human activity. General classifications of expert systems (Frenzel, 1987) are given in Table 1.

In the area of computer-based instruction, expert systems can control a large instructional database, debug student PASCAL programs, design educational products, diagnose mathematical difficulties, teach computer literacy, interpret current events, plan for minority education, predict kindergarten enrollment, or repair microcomputers. The main area of interest for this discussion is computer controlled or level III interactive video and audio instructional systems.

Table 1. Classification of Expert Systems

Control	intelligent automation
Debugging	recommends corrections to faults
Design	development of products by specifications
Diagnosis	Estimation of defects
Instruction	Optimized instruction
Planning	Development of goal-oriented schemes
Prediction	Intelligent guessing of outcomes
Repair	Automatic troubleshooting and fixing

Any expert system logically has three parts (Pigford & Baur, 1990): a rule base, an inference engine, and a user interface. These three logical components are given in Figure 1 below.

The rule base is a set of rules that represent the knowledge of the human expert. Generally the rules are expressed in an IF THEN format. The inference engine is the reasoning mechanism that analyzes the rules to reach a conclusion. The user interface is the total communications between the expert system and the user of the intended expert system. Together, correct rules, an automatic reasoning strategy, and effective communications make an expert system efficacious in the intended domain.

Since the expert system is a piece of computer software, how is it written? The answer is basically in two ways. The expert system can be programmed by a programmer using any language: PASCAL, C, Fortran, or most any high level language. The second method of implementing an expert system is to use a tool called an expert system shell. The shell is easier to use and does not require the author to be a professional programmer.

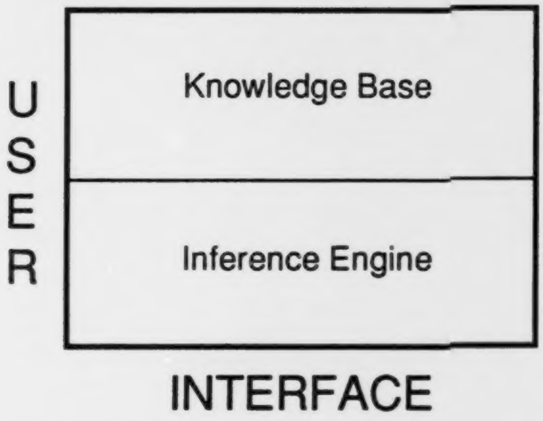

Figure 1. Three parts of an Expert System

The shell contains the automatic reasoning ability or inference engine. Hence, the user of the shell has to supply only the rules and the interface. This makes it possible for non-programmers to implement expert systems in a selected area or domain of expertise. There are many expert systems shells available that run on microcomputers, minicomputers, and mainframes. For interactive video, however, microcomputer based shells are the most useful, affordable, and prevalent.

In summary, expert systems are software programs that display the reasoning ability of a human expert in dealing with a specific problem. Experts systems are composed of three logical parts: the rule (knowledge) base, the inference engine (reasoning mechanism), and the user interface (communications). The expert system software can be written in a computer language by a programmer or implemented with a shell by a non-programmer.

Integration of Expert Systems and Level III Videodisc Applications

Expert systems can be integrated with Level III videodisc applications. As proposed by Baur (Baur, 1988), expert systems can actually be the central or driving force for interactive video and audio peripherals. Prototype systems (Devolder, 1989; Ting, 1988) have been built using an expert system shell to implement intelligent tutoring via a microcomputer based videodisc system.

The rule base of the intelligent tutor (expert system) contains the intelligence for diagnosing, interpreting, or planning the learning outcome. The automatic reasoning mechanism (inference engine of the expert system shell) can control the branching in an instructional application. Generic rules could be as follows:

Rule 29

IF Achievement = Low THEN
Play Videodisc Section R
Give Posttest
Record in the Database

In this rule, if achievement is low, then the inference engine will instruct the system to play a particular section of the videodisc, administer a posttest, and then record the results in the student's record in the database.

Another application might make use of the following rule:

Rule 234

IF Learning_style = Graphic and Motivation = High THEN
Play Videodisc Section E with Graphics

This rule tells the inference engine to play a particular section of the videodisc with overlay graphics turned on when the student is highly motivated and possesses a graphical learning style. If an expert system had several hundred rules, then the inference engine of the expert system shell would examine all rules to determine the appropriate action of the tutoring system.

In the two examples above, the expert system had to access the videodisc, turn environmental controls on or off, administer tests, and record results in a database. If would be much more efficient and economical in the long run, if a new test or new database did not have to be written within the expert system. It would be beneficial if the expert system could behave like a maximal authoring system to communicate with other pre-existing software (Pigford, Henry, & Miller, 1984). Another way to express this concept is to require that the intended authoring tool have an "exit and return" feature. Some expert system shells possess this desirable feature.

This integration of expert systems and videodisc can be perceived as a wheel with the expert system as the center of the wheel and the various software packages as the spokes. See Figure 2.

The core of the integrated system would be an expert system that controlled the learning environment (videodisc, graphics, audio, etc.), and utilized informational systems (database, spreadsheet, statistical, etc.). As the application varied, the utilization of other software would vary.

The integrated system would be much easier to produce if the expert system shell allowed this integration of external software. An expert system shell with its automatic reasoning (branching) mechanism that could utilize external software programs would be an effective authoring tool for Level III videodisc applications. In the next section VP-Expert will be discussed as an authoring tool.

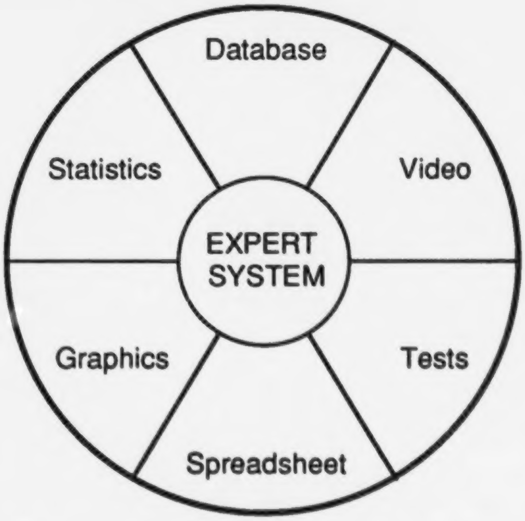

Figure 2. The Integration of Expert System and Videodisc.

VP-Expert as an Authoring Tool

The focus of this paper will now shift from the general concept of using an expert system as an authoring tool to the specific implementation of one microcomputer based shell called VP-Expert. VP-Expert is an expert system shell than runs on IBM compatible microcomputers under DOS 2.0 or higher. The inference engine will be discussed first. The FIND command is the instruction in a VP-Expert program what turns control over to the inference engine to search the rules or knowledge base to reach a conclusion. If the value of a variable GRADE is unknown, then the instruction FIND GRADE will turn control over to the automatic reasoning mechanism to search the rules to determine a value for GRADE. If the inference engine finds a rule with GRADE as the conclusion, then the inference engine will look at the rule condition. For example in the following rule,

```
RULE 45

IF Score > 90 and Assignments = Complete
THEN GRADE = A;
```

the inference engine would now examine the values of Score and Assignments. If the values are found, then the inference engine could determine if GRADE is an A. If the values of Score and Assignments are not found, then the inference engine would examine any rules that would determine Score and Assignments. In any case, the path of the inference engine is automatic in an expert system shell. With the appropriate rules from the designer of the videodisc application, the inference engine serves as the automatic "branching" system for an authoring tool.

The second major feature for an authoring tool is the ability to integrate or utilize an informational base and other pre-existing and specialized software. VP-Expert has these features built in the shell. VP-Expert can utilize information previously stored in database, spreadsheet, and text files. This external data can be read into VP-Expert and actually incorporated in the rule base. The MENU instruction along with GET is used to access a database record from VP-Info, dBASE II, dBASE III, dBASE III+, or other work alike database management programs. The PUT instruction will write information from VP-Expert back to the database. The APPEND instruction will allow VP-Expert to insert a new record into the external database file. Other commands will effect the same integration for spreadsheet access to VP-Planner, VP-Planner-Plus, and LOTUS 1-2-3. Text files can also be transferred to and from VP-Expert. This integration with external information bases is a desirable feature of an effective authoring tool.

The flexibility of VP-Expert is further exemplified by its ability to call external programs and then return to VP-Expert. This "exit and return" feature increase the flexibility of VP-Expert in applications development with videodisc. The user can actually switch from the expert systems interface to spreadsheets with WORKON and then return to the expert system tutor.

VP-Expert can communicate with any external DOS file that has a .BAT, .COM, or .EXE extension. A .BAT or batch file is a file of DOS (operating system) commands that are interpreted one after another as if they were typed at the A> prompt from the keyboard. A DOS file with a .COM extension is an executable file that is limited to about 64k whereas a DOS file with an .EXE extension is an executable file that is not limited in size. (For example, Turbo PASCAL, ver 5.5, produces .EXE files). In any manner, any of these DOS files can be integrated by using the BCALL, CCALL, and CALL commands of VP-Expert. For example, the generic rule discussed in Section two converts to specific VP-Expert code as follows:

```
RULE 29
IF Achievement = Low THEN
CALL Video,"start, stop"
CALL Test
CALL DB,"Results";
```

If rule 29 is activated then the expert system calls an external file, VIDEO.EXE extension which plays the videodisc from the start frame to the ending frame number. Then the inference engine calls on the test program, TEST.EXE, and finally the results of the test are transferred to the DB program. The code above assumes the existence of the three executable files named in the three CALL instructions. (VP-Expert does not have its own videodisc library.) The important consideration is that these three executable files could have been created with many different software compilers or packages.

The second rule from the previous section would translate into the following VP-Expert instructions:

```
RULE 234

IF Learning_style = Graphic and
Motivation = High THEN
BCALL Videog
```

This rule, when activated by a true condition, would execute a batch file which would send instructions to the videodisc to play a certain sequence with graphics overlay on rather than off. Moreover, VP-Expert will assist in controlling the screen during these external program calls (to the videodisc, spreadsheets, database, or specialized software). The instructions are CLROFF and CLRON. In the following sequence of code,

```
DISPLAY "Please wait a minute for the
    calculation."
CLROFF
CALL STAT,"data"
DISPLAY "Statistics are being calculated."
CLRON
CALL Graph,"data"
```

the user is being told to wait a minute while the statistic from the tutoring session is figured. The CLROFF command and the subsequent CALL to STAT.EXE allow the program to run transparently to the user. When the statistic is calculated, the CLRON command reactivates the screen so that when GRAPH.EXE is called the screen will display the statistics with the GRAPH program. The VP-Expert commands to control the screen make the intermixing of programs almost transparent to the user of the intelligent tutoring system. Hence, through the use of the automatic inference engine, access to information bases, and external programs calls, VP-Expert can function as an authoring tool for interactive videodisc applications on IBM compatible microcomputers(The interested reader is referred to the Appendix which contains additional features of VP-Expert such as Graphics, Hypertext, and Chaining.)

Summary

This paper has presented the relationship between expert system shells and authoring tools for Level III videodisc implementations. An expert system which emulates the intelligence of a human can be implemented with computer programming languages or a special tool called an expert system shell. Any expert system is composed of three parts: the rules (knowledge), the inference engine (reasoning or search mechanism), and the user interface (total communications medium). The expert system shell has an automatic inference engine which does not have to be programmed. In using an expert system shell to implement a Level III videodisc system, the automatic inference engine controls the branching in the instructional system. The ability to access external information bases and to utilize external software as an "exit and return" feature can transpose an expert system shell to an authoring tool. VP-Expert has the specific commands to accomplish the same objective as an authoring tool.

Appendix

VP-Expert offers a combination of powerful features that make it appropriate for developing microcomputer-based expert systems. Special features include:

- The ability to exchange data with VP-Info or dBASE database files, VP-Planner, VP-Planner Plus, 1-2-3, or Symphony worksheet files, and ASCII text files.
- An Induce command that automatically creates a knowledge base from a table contained in a text, database, or worksheet file.
- An "inference engine" that uses backward and forward chaining for problem solving.
- Optional development windows that let you observe the behind-the-scenes path of the inference engine as it navigates the knowledge base to solve problems during a consultation.
- Confidence factors that let you account for uncertain information in a knowledge base.
- Simple English-like rule construction
- Commands that allow VP-Expert to explain its actions during a consultation.
- Knowledge base "chaining," which lets you create knowledge bases that would otherwise be too large to fit in memory.
- A built-in text Editor.
- Automatic question generation for finding unknown values of variables.
- The ability to record and graphically display the rule-by-rule search pattern used behind the scenes during a consultation.
- Floating point mathematical functions.
- Rapid execution of the knowledge base.
- The ability to execute external DOS programs.
- Hypertext
- Dynamic images.
- SmartForms.
- Graphics primitives.
- Mouse support.

In addition a Structured Query Language (SQL) interface and special graphics libraries can be added to VP-Expert. VP-Expert is available in a full version or an educational version. For more detailed information contact:

Paperback Software International
2830 Ninth Street
Berkeley, CA 94710
Phone (415) 644-2116
FAX: (415) 644-8241

Ms. Lori Peterson at Paperback Software International can give you more information on educational accounts, whereas Mr. Terry Schussler can provide detailed technical information.

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Selected Formal Papers from the

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IDENTIFYING RESISTANCE TO COMPUTER BASED TRAINING

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Abstract

This practical discussion will suggest likely reasons for resisting CBT, with particular attention being paid to trainers. The discussion will end with a strategy for overcoming resistance.

Introduction

Whenever you suggest a plan that may cause change in your organization, you need to become aware of who may resist the change and why they would do so. The implementation of computer based training (CBT) is, in fact, the introduction of major change. CBT requires the use of new technology, cooperation between departments that may not be used to working together, and redefining the role of some of the trainers.

Over the past seven years the author has had the opportunity to speak with many CBT professionals. A high degree of agreement seems to exist with regard to the identities of those likely to resist CBT and why they might do so. Surprisingly, the major opposition often arises from other trainers. This article will discuss potential resistors, strategies for overcoming this resistance, and specifically examine how your fellow trainers may view CBT.

Identifying Potential Resistors

Since successful change requires the involvement of employees, an initial step in overcoming resistance to any change such as the implementation of CBT is to identify whose resistance might be anticipated. The identities will change slightly, of course, from organization to organization, but the basic premise for identifying the important players remains the same. Identify each person or group that has an interest in the current product, or would be impacted by the proposed change. For CBT, students, trainers, executive managers, and line management should have an interest in the current training. The implementation of CBT would impact, to some extent on all these groups and probably would impact also on the data processing department.

A complete analysis of possible resistance to change requires examining each person who has influence within each group. For now, let us limit the analysis to identifying what might be some of the reasons each of these groups might resist CBT.

Table 1 lists nine possible general causes for resisting CBT and the likely areas of high resistance for each of five groups.

CAUSE OF RESISTANCE	GROUP				
	Top Mang.	1st Line Mang.	Trainers	Students	DP Group
Cost/Benefit	●				●
Loss of Job		●	●		
Loss of Control			●		●
Dealing with Technology			●	●	
Presumptions	●		●		
Ignorance	●	●	●		
Isolation of Students			●	●	
Implementation Problems	●		●		●
Culture	●		●		

Table 1. Potential Resistance.

General Reasons for Resisting

The executive managers, labeled Top Mang. on Table 1, are the ones in an organization from whom permission must be obtained before expending funds to purchase computers, consultant services,commercial CBT software, or CBT development software. Their concerns center around cost and the impact of the change of the organization.

Thus, they are highly concerned about the cost-benefit ratio, the problems associated with the implementation of CBT, and the impact of CBT on the organizational culture. Also, they will be affected by their presumptions regarding training since CBT is different than the traditional model wherein an instructor leads a group of passive learners. Since CBT is a relatively new phenomenon within corporate training, there may be resistance due to their lack of familiarity with CBT.

The line managers, labeled 1st Line Mang., do not have many reasons for resisting CBT. Unfortunately, this is probably because many line managers are not that involved in training. As long as employees get the training they need and are away from their job for as short a time as possible, little consideration is given to training. The major reason this group might balk at CBT is unfamiliarity with CBT.

Employees who are the students will be a little more fearful of CBT. More specifically it's the computer part of CBT about which they are concerned. It may be that there is some latent fear of computers taking over jobs, or it may be simply that they have never used a computer before and are afraid they may look foolish. Another significant concern is that they perceive CBT as working alone at a computer. One of the motivators identified for attending in-service training is the socialization that occurs in the class. The students do not want to lose this and are fearful of any change that may alter the existing training climate.

The data processing (DP) personnel will be even more concerned. They are accustomed to being seen as the computer experts and are rather anxious to defend their territory. Thus, they fear a loss of control in the computer area due to the implementation of CBT. They will be concerned about who will have the final word on hardware and other technical decisions. These fears and concerns are exacerbated by their ignorance in the area of CBT. Since the CBT project may possibly compete for funds with various DP projects there will be a natural concern on the part of the DP personnel with regard to the cost-benefit aspects of CBT. To a lesser extent, the DP personnel will be anxious about the direct threat to their jobs when outsiders start to become more familiar with computers, and the impact of CBT on the organizational culture. A final reason for resisting CBT may be the presumptions the personnel hold concerning training and the role of trainers.

The group most threatened by the change is the training staff. At first, this may seem surprising because trainers like to think of themselves as creative and innovative persons. There are, however, some very legitimate reasons why trainers would fear and thus resist CBT. First, their jobs are being directly affected by the proposed change. They will have to learn new skills and assume new roles. They fear they will lose some of the control they now have in "their" classroom. They may be uncomfortable with working with an emerging and constantly changing technology. Implementation of CBT may challenge their training philosophies, change the organizational culture, and isolate them from their students. Likewise, resistance may be precipitated by the potential increased workload implementation will cause and the normal resistance to change some of us possess.

Identify Specific Reasons to Resist or Accept CBT

Once you have identified the appropriate parties and identified their general reasons for resisting CBT, you need to more specifically identify what would motivate each person to either resist or support the proposed CBT effort. Different persons within the same group may have slightly different reasons for their attitude toward CBT. Therefore, prepare an analysis for each person. Table 2 shows one form such an analysis could take.

	SUPPORT	RESIST
BENEFITS	1	2
DRAWBACKS	4	3

Table 2. Analysis of Potential Consequences.

The key to understanding this chart is to understand that there are individual advantages and disadvantages to either supporting or resisting the CBT project. Each person will have reasons listed in each of the four quadrants, though the specific reasons will vary from person to person.

A person may decide to resist CBT because of the advantages they see in so doing (Quadrant 2), or due to the perceived drawbacks of implementing CBT (Quadrant 4). Similarly, a person may decide to actively support CBT because of possible benefits (Quadrant 1), or because of disadvantages of resisting the effort (Quadrant 3). Since each individual will likely have reasons in each of the four quadrants, some persons will choose to remain neutral on the subject.

Three major groups, thus, will emerge. One group will actively support CBT and a second will actively resist CBT. The third group consists of those who perceive a negative impact if they either actively support or actively resist CBT.

The advantages for resisting CBT would be determined and identified in the upper right quadrant. These are desirable results that should occur if a person is successful in resisting CBT. For example, a trainer would be able to continue to do what he/she liked best - stand-up training if CBT is not allowed to intrude.

The disadvantages of supporting the CBT effort would be listed in the lower left quadrant. These are results that will have a negative impact on the person who successfully supports the implementation of CBT. In many cases these are the reverse of the reasons listed in the upper right quadrant. For example, a trainer might see a negative aspect to using CBT since it will reduce the amount of time spent in giving lectures.

The advantages for supporting CBT are listed in the upper left quadrant. These are the anticipated positive results if CBT is adopted. For example, a trainer would develop a new job skill due to working with the project.

The disadvantages of not supporting CBT would be listed in the lower right quadrant. These are anticipated results that may have a negative impact on the person who actively resists CBT. Let's take a closer look at the trainers so that we may fully understand the potential areas of resistance and learn to overcome them.

Trainers' Resistance to CBT

At a class given by Effective Training Inc. CBT developers of varying levels of experience were asked to independently rate the potential resistance to CBT of the groups previously discussed. The collected results formed part of the input for Table 1. As the developers shared their perceptions, it became quickly evident that the trainers, as a group, were the persons most likely to resist the implementation of CBT. The results of this unscientific study are supported by the presentations given at various CBT professional meetings. A common topic is how to interest instructors in CBT.

Trainers tend to be outgoing persons who are interested in helping students with whom they come into contact. They want their students to learn, and in theory, they are paid to do this. Why then do we find that trainers are often among those who most resist CBT? Because, as was noted above, trainers are the group most affected by the changes precipitated by CBT.

Table 3 lists some reasons trainers may support or resist CBT. The chart is generic in that it attempts to capture numerous motivations. The chart you would prepare would be based on your perceptions of a specific individual.

The chart is similar in format to Table 2, but includes an additional aspect - "Dimensions." Consider each reason for accepting or resisting CBT in terms of its potential impact on the person you are analyzing. There are three sets of dichotomies to consider. A reason is either 1) Personal or Organizational, 2) Immediate or Delayed, and 3) Certain or Speculative.

A Personal reason is one that a person believes will have an impact on him/her as an individual. An Organizational reason will impact on the organization, but not especially on the person. The second dichotomy examines the question of whether the reason will likely cause an Immediate or Delayed result. The final dimension attempts to determine the likelihood of the results.

	SUPPORT	RESIST
BENEFITS	New Job Skill (PIC) Seen as Expert (PDS) Seen as Innovator (PDS) Do Job Better (PDS) Increase Influence (PDS) Possible Advancement (PDS)	Keep Influence (PIC) Do What Good At (PIC) Keep Kudos (PIC) Less Work (PIC) Low Risk (PDS) Save Money (ODG)
DRAWBACKS	More Work (PIC) Difficult to Manage (PIC) Tedious (PIC) Reduced Student Contact (PDS) Delayed Praise (PDC) High Risk (PDS) Will Fail (PDS	Seen as Block (PIC) Embarrassed if Succeeds (PIS) Become Stagnant (PDS) Lost Opportunity (PDS) Fall Behind Others (PDS)

Table 3. Analysis of Potential Consequences for Trainers.

Benefits for Supporting CBT

Quadrants 1 and 3 of Table 3 suggest several reasons for deciding to actively support CBT. Quadrant 1 lists the possibility that you will grow as a trainer by learning a new job skill. You may be seen as an innovator who possesses special expertise. This may help in terms of organizational influence and advancement and raises the possibility of building an "empire" based on CBT.

And finally, a trainer who is truly concerned with improving the instruction provided to the students should be willing to explore new methods of delivery. CBT will allow you to provide more specific instruction to a larger number of persons than you now serve. There are many potential benefits to the students and the organization of using CBT, and each of these benefits is an additional reason for supporting CBT.

Quadrant 3 submits several reasons why there may be a negative impact to resisting CBT. These include falling behind others, lost opportunity, and continued stagnation.

Benefits of Resisting

Quadrants 2 and 4 list several reasons why trainers would want to actively resist the development or purchase of CBT. Quadrant 2 notes that traditional methods of instruction will allow the trainers to keep their personal influence. In a lecture setting the instructor is the focal point of the class. The trainer, thus, sets the pace and direction of the class. Who among us would deny that there is a tremendous ego satisfaction in standing in front of a class and receiving their approval? For example, one developer told of showing some commercial CBT to a trainer who thought it was quite good, but asked "Instead of buying a copy for each student, couldn't we just have one copy for me in the front of the room and I'll ask the students what answer they would like to enter?" The most important thing to this trainer was maintaining his influence in the classroom.

A second reason for resisting is that most trainers have spent long years honing their skills as stand-up trainers. They are good at it, and naturally want to continue to do what they do well. We have achieved a certain status based on our classroom their skills and don't want to abandon those skills that have served them so well.

Third, experienced trainers get to coast a little because they are experienced. They have polished their lesson plans and presentations to almost perfection. Remember the early years and all the time it took to get ready to give a class? Now, a few minor changes and a quick glance at the lesson plan suffices. Why waste all this effort and start from almost the beginning? CBT requires a lot of effort to produce and it's so detailed. Instructors can always be a little vague in class and if they have to they can fake it, but CBT can't be faked. It's just too much work to help produce CBT, particularly since trainers are convinced that they are overworked now.

Fourth, the implementation of CBT involves both expending funds and taking risk. Two benefits of actively resisting CBT, therefore, occur. First, from a short-term perspective, you save money. And, you avoid taking any personal or organizational risk.

And finally, a good reason to resist CBT is because it may take the students from us. One of the joys of training is the interaction trainers have with the students. Many people became trainers because they liked people. Being in a room where there are a lot of people sitting at computers working independently does not seem that rewarding. Trainers may believe they will miss the warmth they used to enjoy and the appreciation of their students.

Quadrant 4 also suggests some reasons for avoiding CBT. These include the delay of praise from students, the tedious nature of CBT development, and the potential difficulty in managing CBT.

Drawbacks to Actively Taking a Position

There are negative aspects of either actively resisting or supporting CBT. Resistance may cause one to be labeled as troublesome by management, or to fall behind more progressive colleagues. Support for the effort creates risk, and may cause some unpleasant results such as an increased work load or a reduction in interaction with students.

Some persons, thus, may take a neutral position for one of two reasons. For some the perceived benefits and drawbacks to CBT may appear equal. They therefore do not take a position. Others may tend toward supporting or resisting the project, but fear the consequences of so doing. Such persons become passive supporters or resistors.

Overcoming Resistance

The information prepared above forms the basis of a strategy for overcoming resistance. The reasons listed in each of the four quadrants can guide you in dealing with each person. In order to gain active support identify all the reasons where the implementation of CBT should result in a perceived benefit. You should readily agree with the individual that the benefits they have recognized are significant. You may also share with them some of the other possible benefits that may accrue.

Similarly, identify all the reasons why actively resisting CBT might be detrimental to someone. You would concur that there certainly might be some undesirable side effects of resisting CBT and attempt to heighten their awareness of these effects. You may well be able to interject some additional drawbacks of resisting CBT.

On the other hand, you would want to lessen the significance of the negative impacts they view as occurring if CBT is implemented. And of course, you would attempt to ally the fears they have that form the basis of reasons why to resist CBT. For example, you might point out that using CBT allows the instructor more time for individual interaction with students.

Remember that the most influential reasons will be those that are rated Personal, Immediate, and Certain in the dimensions column. You would, thus, attempt to especially bolster and support the person in these areas. And you would pay particular attention to overcoming reasons to resist that have these three ratings in the dimension column. The use of this strategy should enable you to increase the assistance of the supporters, obviate the objections of the resistors, and move the uncommitted to your point of view.

Conclusion

While change potentially is threatening to all those affected, some individuals will be more threatened than others. To help overcome resistance to CBT, you should first identify those who are likely to be potential resistors. Next you should attempt to evaluate specific reasons for supporting or fighting the development of CBT. And finally, use this knowledge to show the potential resistor the benefits that they can derive from supporting CBT.

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Selected Formal Papers from the

Special Interest Group for Music Education (SIGMUSIC)

CREATING ADAPTIVE TESTS OF MUSICAL ABILITY WITH LIMITED-SIZE ITEM POOLS

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Abstract

Although musical ability tests have enjoyed a 70-year history of development and refinement, they continue to be plagued with problems of inefficiency, poor reliability and poor validity. The shortcomings of these tests are so serious that many music educators have become completely disenchanted with them and have sought alternative methods of evaluation. One promising alternative to conventional music testing is computerized adaptive testing. Research to date has indicated that adaptive music tests require considerably fewer items to match or surpass the reliabilities and validities of conventional music tests. Much of the superiority of adaptive music tests can be attributed to the large pool of items that an adaptive test can draw from. The purpose of this study was to assess the quality of an adaptive test of musical ability that used an item pool two to three times smaller than those used in previous investigations. Results indicated that the adaptive music test used up to 62% fewer items to reach reliabilities and validities comparable or superior to those of three conventional music tests. These findings suggest that adaptive tests can provide significant improvements in the assessment of musical ability even when limited-size item pools (90-100 items) are used.

Introduction

Formal tests of musical ability tests can be traced back to the pioneering work of Carl Seashore at the University of Iowa with his Measures of Musical Talents (Seashore, 1919). Seashore assessed aural acuity in a variety of modes (pitch, duration, intensity, timbre, rhythm and tonal memory), emphasizing the relationship of perceptual ability in musical accomplishment. His work sparked a sizeable amount of research and inspired the development of several additional musical ability tests (Bentley, 1966; Drake, 1957; Gaston, 1957; Gordon, 1965; Wing, 1961). The most notable of these is the Musical Aptitude Profile (1965) by Edwin E. Gordon, which is acknowledged by several music testing experts (e.g., see Buros, 1972) as the best musical ability test currently available. Since 1965, Gordon has developed additional tests for young children (1978), but the basic approach to music aptitude testing has not changed, despite advancements in technology and testing theory, since the time of Seashore.

Throughout their long history, musical ability tests have been used primarily in music research studies but have not enjoyed widespread popularity among practicing music educators. This is ironic because music educators should benefit most from the information provided by tests since test results could be used to diagnose music learning difficulties, detect discrepancies between achievement and ability, and identify individuals who are likely to become excellent musicians. Although one reason music educators do not use musical ability tests is that they are unaware of them, the primary reason is that the tests themselves have shortcomings. Even the best commercially-available musical ability tests are inefficient and often show evidence of only low to moderate reliability and validity (Shuter-Dyson & Gabriel, 1982). These shortcomings have led some music educators to abandon these tests and to seek other methods of evaluation (Davies, 1978). Until the advent of computerized adaptive testing, however, no superior alternatives emerged.

Adaptive testing procedures may help overcome some of the problems of inefficiency, poor reliability, and poor validity that have plagued music tests for the last 70 years. Prior research on adaptive music tests with large item pools (180 or more items) has shown that adaptive tests using up to 69% fewer items can match or surpass the reliabilities and validities of conventional music tests. The primary purpose of this study was to assess the efficiency, reliability and validity of an adaptive music test that used a pool two to three times smaller than those employed in previous investigations.

Advantages of Adaptive Testing

Commercially-available tests of musical ability are inferior to adaptive tests because they use a fixed set of items that are administered to all examinees regardless of their ability levels. Since examinees generally differ in the ability measured by a given test, some items will be too easy and others too difficult to be informative about their abilities. Nonetheless, examinees may devote considerable time and effort to answering such items. Adaptive tests are aimed at improving measurement quality by successively presenting items of appropriate difficulty, selected from a large item pool, to each examinee according to performance on previous items. When this procedure is employed, examinees respond only to items matched to their ability levels, making the test more efficient; they respond to a greater proportion of items matched to their ability levels, making the test more reliable; and since they respond to a more reliable set of items, their scores potentially are more valid.

Adaptive Testing Research Outside of Music. The anticipated advantages of adaptive tests over conventional fixed-item tests have been demonstrated in studies by McBride and Martin (1983), Moreno, Wetzel, McBride & Weiss (1984), Urry (1977), and Weiss (1982). Taken as a whole, these studies indicate that adaptive testing procedures require an average of 50% fewer items to reach reliabilities and validities comparable or superior to those of conventional tests. These promising results have led to the development of the first operational adaptive aptitude tests, which presently include adaptive versions of the Armed Services Vocational Aptitude Battery (Sympson, Weiss & Ree, 1982), and the Differential Aptitude Tests (McBride, 1986).

Adaptive Testing Research in Music. It is important to point out that with one exception (Vispoel, Coffman and Scriven, 1990), all present operational computerized adaptive tests use visually-administered items. However, adaptive testing procedures need not be restricted to visual stimuli. In fact, it can be argued that adaptive tests for assessing music listening abilities may be more beneficial than adaptive tests assessing skills via visually-administered items. The reason for this is that fatigue and lapses in concentration have a greater impact on performance on listening tests than on visually-administered tests (McLeish, 1968). Since listening test items usually are presented only once, any lapse in attention may result in an incorrect item response. This problem is less serious in visually-administered tests, because examinees are able to reread a given item as many times as they desire before responding. The high level of concentration required on listening tests is difficult to maintain over a long period of time and quickly leads to examinee fatigue. If an examinee experiences fatigue or loses concentration during a listening skill test, the resulting scores are likely to be invalid. Thus, the improvement in test efficiency gained through adaptive testing procedures is particularly desirable when assessing musical ability.

The only research to date on adaptive tests of musical ability has been conducted by Vispoel (1986, 1987a, 1987b, 1990) and his associates (Vispoel and Twing, 1989; in press). Vispoel (1987a) developed an operational version of a test designed to assess tonal memory (the ability to remember melodies) on the PLATO computer system. Subsequent studies (Vispoel and Twing, 1987; Vispoel, 1990) employing computer simulation techniques to compare the efficiency, reliability, and validity of this adaptive test to a variety of conventional music tests yielded results similar to those found for adaptive tests using visually-administered items. Specifically, the adaptive test, using up to 69% fewer items, yielded reliabilities and validities comparable to or superior to those of conventional music tests.

While research assessing the feasibility of adaptive tests of musical ability has been promising, it is important to note that the actual development of an adaptive test is time consuming and complicated. Part of the difficulty is in constructing an item pool that contains a sufficient number of items to measure all examinees ability levels with high precision. In previous investigations (Vispoel, 1987a, 1990; Vispoel and Twing, 1989), pools of 180 and 278 items were used. The goal of the present investigation was to assess the feasibility of developing an adaptive test of musical ability with a considerably smaller item pool.

Purpose of the Study

This study had three main objectives:

1. To compare the reliability of the adaptive test to those of three types of conventional tests formed from the adaptive test pool: peaked tests, flat or rectangular tests, and tests containing the most discriminating items. [These comparisons were made at several test lengths (5, 10,..., 40 items).]
2. To assess the average number of adaptive and conventional test items required to yield selected levels of reliability (i.e., .80, .85, .90).
3. To compare the validity coefficients for the adaptive and conventional tests at various lengths using several criterion measures including the Drake Musical Memory Test, the Seashore Tonal Memory Test, and indices of musical experience and training.

Methods and Data Source

The present study used data from which an operational computerized adaptive test of tonal memory was developed (See Vispoel, 1987a; Vispoel, Coffman, and Scriven, 1990). Items for the adaptive test were constructed to parallel those of commercially available tests, notably, the Seashore et al. (1960), the Wing (1968) and the Bentley (1966) tonal memory tests. A typical test item requires an examinee to compare two versions of a short melody. On the second playing, either the same melody is repeated or one note is altered. Examinees indicate the number of the note that has changed or indicate that the two playings of the melody are the same.

The adaptive test item pool contained 93 items, approximately 1/2 to 2/3 fewer items than those used in the previous investigations. In addition to responding to all of the 93 items in the pool, examinees completed the Seashore Tonal Memory Test, the Drake Musical Memory Test and an investigator-designed questionnaire assessing musical background and training. These latter measures, which served as criterion variables in the investigation of test score validities, are described in more detail in Table 1.

The present study simulated computerized adaptive tests of various lengths using the actual responses of 163 examinees from the Vispoel (1987a) study. A "maximum information" item selection strategy was employed (See Hambleton and Swaminathan, 1985, Chapter 7). The first item on each adaptive test is the most discriminating item available at average difficulty. That item is scored immediately and ability is estimated. Next, the item that provides maximum information at the estimated ability level is administered and ability is reestimated. The third item is chosen to provide maximum information given the new ability estimate. This process is continued until the test reaches the desired length (5 items, 20 items, etc.).

Table 1. A Description of Criterion Measures.

MEASURE	DESCRIPTION
Drake Musical Memory Test	A 54-item standardized test of musical memory.
Seashore Tonal Memory Test	A 30-item standardized test of tonal memory.
Professional Musical Performing Experience	Examinees indicated whether they had ever played music professionally (been paid to perform music). They were coded 1 if they had played professionally and 0 otherwise.
College Music Experience	Examinees indicated whether they were music majors or music minors. They were coded 1 if they were a music major and 0 otherwise.
Instrument Playing Experience	Examinees indicated the number of years they have played a musical instrument.

In addition to the adaptive test, three types of fixed-item conventional tests (flat, peaked and maximum discrimination) were developed from items within the adaptive test pool. In a fashion similar to McBride and Martin (1983), and Vispoel and Twing (1989), test lengths identical to the simulated computerized adaptive tests were generated by identifying subsets of items that for the flat test were most discriminating across a wide range of abilities, for the peaked test were highly discriminating in the middle of the ability range only, and for the maximum discrimination test were the most discriminating items in the pool independent of difficulty level.

Item parameter estimates, based on data from 468 high school and college students, were obtained using LOGIST V (Wingersky, Barton, & Lord, 1982) under the modified 3-parameter logistic model (i.e., the "c" or guessing parameter estimates were fixed). These items were calibrated and tested for unidimensionality and model fit in a previous study (Vispoel, 1987a).

Since scores for the present simulated adaptive and conventional tests were based on actual responses to test and questionnaire items, reliability and validity results should be similar to those that would be obtained if examinees had actually taken the conventional and adaptive tests in the prescribed manner. All adaptive and conventional tests were scored using item response theory procedures to eliminate possible confounding of results due to scoring method differences.

Results

Reliability. Estimated reliabilities for the adaptive and conventional tests at various fixed test lengths are given in Table 2. Reliability estimates are based on a formula suggested by Urry (1977) and Green, Bock, Humphreys, Linn and Reckase (1984) in which reliability is defined as "One minus the reciprocal of test information." As can be seen from Table 2, the adaptive test reliabilities matched or exceeded those of the conventional tests at all test lengths. The differences between the adaptive and conventional test reliabilities were most pronounced at short test lengths (i.e., 5 and 10 items).

Table 2. Estimated Reliabilities at Various Test Lengths.

	Type of Test			
Test Length	Adaptive	Peaked	Flat	Max. Disc.
5	.80	.00	.00	.00
10	.90	.62	.71	.78
15	.92	.86	.82	.87
20	.93	.91	.87	.91
25	.94	.94	.90	.93
30	.95	.95	.92	.95
35	.96	.96	.92	.96
40	.96	.96	.92	.96

Efficiency. The average number of adaptive and conventional test items required to obtain reliabilities of .80, .85, and .90 are given in Table 3. As shown in the table, the adaptive test reached reliabilities of .80, .85, and .90 after an average of only 5, 7, and 10 items, respectively. In comparison to the conventional tests, the adaptive test required from 44% to 62% fewer items to reach these reliabilities.

Validity. Table 4 contains the validity coefficients between the criterion measure scores described in Table 1 and scores from the adaptive and conventional tests at selected test lengths. Although less striking than the results for efficiency and reliability, it is apparent from Table 4 that, in most cases, the adaptive test yielded higher validity coefficients than the conventional tests. Consistent with the findings for reliability, differences in validity favoring the adaptive test were greatest at short lengths. The most sizable increases in validity coefficients of all tests occurred as test length increased from five to ten items. Validity coefficients for all tests were reasonably stable after 15 to 20 items. Combining the results for the three analyses, it would appear that 15-item adaptive tests provide an excellent combination of high efficiency, reliability, and validity.

Table 3. Test Lengths Needed to Reach Selected Reliability Levels

		Reliability Level		
		.80	.85	.90
Average Test Length	Adaptive	5	7	10
	Peaked	13	17	23
	Flat	12	14	18
	Max. Disc.	11	13	18
Average Difference in Test Length (Conventional-Adaptive)	Peaked-Adaptive	8	10	13
	Flat-Adaptive	7	7	8
	Max. Disc.-Adaptive	6	6	8
Percent Reduction in Test Length (Adaptive versus Conventional)	Peaked vs. Adaptive	62	59	57
	Flat vs. Adaptive	58	50	44
	Max. Disc. vs. Adaptive	55	44	44

Educational Significance

The results of this study along with previous investigations by Vispoel and his associates strongly support the feasibility of adaptive tests of musical ability. These tests may help overcome the problems of poor reliability and efficiency that have plagued even the best existing conventional musical ability tests such as Gordon's Musical Aptitude Profile, (1968). As Whellams (1971, p. 418) notes, "The norms associated with Gordon's Musical Aptitude Profile indicate that ninety-nine percent of testees in the standardization sample scored at least one-quarter to nearly one-half (depending on age) of the available points. In other words, all testees spend at least a quarter of the total test administration time, i.e., about two and a half hours responding to items for which play no part in discriminating between them. This means that on the average, every MAP tester has forty minutes of his time wasted."

The problems that Whellams points out are exactly those that are most readily solved by adaptive testing. The present results suggest that important improvements in reliability, efficiency and validity can be realized with adaptive music tests having relatively small item pools.

Table 4. Validity Coefficients Between Adaptive/Conventional Test and Selected Criterion Measure Scores

Criterion	Test	Test Length							
		5	10	15	20	25	30	35	40
Drake Test (N=82)	Adaptive	.63	.68	.69	.72	.71	.73	.72	.73
	Peaked	.57	.60	.66	.66	.68	.68	.69	.71
	Flat	.54	.54	.64	.66	.67	.70	.69	.70
	Max. Disc.	.59	.63	.69	.67	.67	.68	.68	.69
Seashore Test (N=82)	Adaptive	.68	.76	.80	.80	.81	.82	.83	.83
	Peaked	.69	.73	.78	.78	.79	.80	.81	.81
	Flat	.62	.72	.75	.74	.75	.77	.77	.79
	Max. Disc.	.64	.72	.78	.77	.78	.79	.77	.77
Professional Performing Experience (N=163)	Adaptive	.43	.48	.48	.48	.48	.49	.48	.49
	Peaked	.37	.44	.48	.48	.50	.51	.50	.51
	Flat	.39	.43	.45	.48	.48	.48	.49	.49
	Max. Disc.	.39	.47	.47	.49	.49	.51	.51	.52
College Music Experience (N=163)	Adaptive	.49	.54	.55	.55	.56	.56	.56	.57
	Peaked	.42	.49	.50	.52	.55	.55	.55	.55
	Flat	.41	.48	.52	.55	.55	.55	.56	.55
	Max. Disc.	.42	.52	.53	.55	.55	.57	.57	.59
Instrument Playing Experience (N=163)	Adaptive	.54	.56	.57	.57	.58	.59	.59	.60
	Peaked	.50	.55	.54	.55	.57	.57	.57	.56
	Flat	.45	.51	.55	.57	.58	.57	.59	.59
	Max. Disc.	.46	.55	.57	.58	.58	.59	.60	.60

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Selected Abstracts for the

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PILOT
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USING UTAH PILOT TO CONSTRUCT A CAI PROGRAM TO REPLACE THE GENERAL LIBRARY TOUR

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Abstract

The purpose of this study is three-fold. First it determines if college freshmen who use a computer-assisted instruction (CAI) program will have higher adjusted post-test means than students who take a traditional library tour or students with no formal library instruction. Second, it ascertains whether a computer-assisted instruction program is more cost effective than the traditional library tours. Finally, it reveals if students prefer being taught general library orientation and the use of basic reference tools using a computer-assisted instruction program instead of taking a traditional library tour.

Computer-assisted instruction has been widely used throughout various levels of education as a teaching tool in lieu of the more traditional methods of lecturing, working with programmed texts or using diverse types of audio-visual instructional methods. Schloss, Wisniewski and Cartright, in their 1988 article "The Differential Effect of Learner Control and Feedback in College Students' Performance on CAI Modules" in the Journal of Educational Computing Research, state that the research and use of computer-assisted instruction is very much of current interest in higher education (Schloss, 1988, p. 141); however, little is presently being done in the library profession. Even though an interest in using computers in the academic library has been present for some time, Mignon Adams expressed concern in her April 1981 Catholic Library World over the lack of instructional media materials for use in academic libraries. Adams noted that numerous commercially- produced materials existed for elementary and secondary libraries. She surmised that although few commercially- produced materials were being generated for academic library use, locally produced media materials proved that academic librarians were very interested in using this type of instruction (Adams, 1981, p. 397).

The purposes of this study were to 1) determine whether college freshmen who used a computer-assisted instruction program would have higher adjusted post-test means than students who took a traditional library tour or students with no formal library instruction, 2) ascertain whether a computer-assisted instruction program is more cost effective than the traditional library tours, and 3) discover if students prefer being taught general library orientation and the use of basic reference tools using a computer-assisted instruction program to taking a traditional library tour. To accomplish these first two objectives, instructors of ENG 1020 Rhetorical Writing classes at Central Missouri State University were asked to volunteer their classes to participate in an experimental study. The eight classes that volunteered were divided into three groups: computer-assisted instruction group, tour group and a control group (which received no formal instruction). Three classes, with a total of sixty-eight students, made up the computer-assisted instruction group; three classes, with a total of sixty-four students, made up the tour group; and two classes, with forty students, comprised the control group.

Each group was given a pre-test and a post-test to measure the amount of difference in the learning which took place between the pre- and post-tests. Each test also served another purpose. The pre-test was utilized to collect demographic data about each student, such as current student status, previous involvement in library work, knowledge of library skills, size of high school graduation class, and previous experience or skills with computers. The post- test was used to gather information on the students' opinions and evaluation of the particular treatment (computer-assisted instruction or library tour) to which they were exposed.

An alpha level of .05 was set to determine the probability level for rejecting or not rejecting the null hypothesis of the first research objective. Analysis of Covariance and the Scheffe procedure were the statistical methods used to determine the significance of relationships between the three groups and among the post hoc population sub-groups. The second research hypothesis was tested by determining and comparing the costs needed in order to conduct ENG 1020 tours and the costs necessary for constructing and implementing a computer-assisted instruction program to provide the same instruction. The study was completed by comparing the costs of the two teaching methods for varying lengths of time -- covering one year and for a period of five years.

The final research hypothesis was tested on the basis of answers to ten statements on the post-test which asked the students to evaluate the method of instruction in which they had participated. Two of these statements were answered with a "yes" or a "no," seven were answered using a Likert-type scale (with four possible choices of strongly agree, agree, disagree, and strongly disagree), and the final statement was answered using a five-part scale ranging from poor to excellent.

The researcher, having conducted ENG 1020 tours for the past eight years, designed a computer-assisted instruction program entitled "Libraries and the Search for Knowledge: A Computer Program" using version 7.0 of Utah PILOT (Programmed, Inquiry, Learning Or

Teaching). The make-up of the program follows the typical instructional-design procedures and includes:

1. An intended audience to use the program.
2. Identification of the objectives to be covered.
3. Organization of instruction into specific sequences.
4. Development of program content.
5. Procedure to determine the effectiveness of the program in covering the objectives (Crandall, 1987, p. xv).

Although PILOT is limited with regard to graphic capabilities, it was chosen because it can be mastered by people who do not have a strong computer programming background. In essence, a person who uses PILOT to construct a CAI program needs to be a specialist in a particular subject, rather than a computer programmer. If the experiment proves successful, the duplication of such a program using PILOT is feasible and can be adapted by other librarians for use at any academic institution.

The ENG 1020 computer-assisted instruction program was constructed in separate modules, totaling thirteen. In order to begin using the program the user places the disk in the computer drive and turns on the machine. The program is equipped with an autoexec.bat file that automatically takes the user to the beginning of the program. Once underway, the student must complete the program in a single session. The following title of each module follows.

Module One: Introduction to the Program.
Module Two: User Information/Interaction.
Module Three: Introduction to Ward Edwards Library.
Module Four: Dewey/LC Classification Systems.
Module Six: Library of Congress Subject Headings Guide.
Module Seven: The Catalog Card.
Module Eight: Library of Congress Call Number.
Module Nine: Location of Books.
Module Ten: Periodicals/Periodical Indexes.
Module Eleven: Readers' Guide to Periodical Literature.
Module Twelve: Newspapers. Module Thirteen: Final Exam.

Summary of Findings

The present study confirmed earlier research which had reported that the vast majority of students utilizing computer-assisted instruction learned as much as, or more than, those students using more traditional methods of instruction. An analysis of findings for the teaching method effectiveness part of this study is discussed first, followed by the findings of the students' evaluation of the methods of instruction, the cost effectiveness results and the post hoc analyses.

Teaching Method Effectiveness. At the onset the three groups were comparable in the scored mean averages after taking the pre-test. After each group concluded the post-test, the computer-assisted instruction group showed a significantly higher adjusted post-test mean, achieving a probability level of .0001. This far exceeded the alpha level of .05 that was originally set. Another set of analyses was conducted to determine if there were individual differences between the computer- assisted instruction group's adjusted post-test means and those of the tour group and the control group. The results of the analysis of the individual adjusted post-test means showed that the computer-assisted instruction group, when compared to the tour group and the control group, was shown to be significantly different at the .05 level. The comparison of the adjusted post-test means of the tour group also indicates that this teaching method proved to be significantly different at the .05 level over the adjusted post-test means of the control group.

Teaching Method Evaluation. Responses to the ten questions on the post-test designed for collecting data for evaluating the students' opinions of the teaching method to which they were exposed were tabulated. Most students in both the CAI group and the tour group felt that their respective teaching method helped them to better understand the lay-out of the library and the basic research tools located there. The majority of students in each group also felt that the material was adequately covered in the CAI program or by the tour guide. There was also little disagreement among the two groups of students when asked if they would recommend that other students select the treatment to which they were exposed. Both groups would recommend the teaching method to other students. When asked about their ability to take notes while experiencing the treatment, a high majority (88.2%) of the computer-assisted instruction group indicated they were allowed time to take notes, with sixteen (23.5%) stating that they did take notes. Only thirty-five students (54.7%) in the tour group felt they had time to take notes, with two students (3.1%) actually doing so.

Another area of disagreement between the two groups appeared when they were asked if the treatment had been too long. Even though the time for both treatments was virtually the same, less than fifty percent (45.3%) of the tour group felt the tour was too long, while over eighty percent (82.4) of the CAI group felt the treatment was too long. This does not seem necessarily one-sided when one considers that the CAI group had to begin and end the treatment in one sitting with no time for a break. This factor could account for the consensus of the CAI group indicating that the CAI program was too long.

Finally, there was little difference in the over-all rating given the treatment method by either group. The majority in both groups indicated that they felt the teaching method in which they had participated was average or above.

Cost Effectiveness Evaluation. Direct costs were figured for providing tours and for the construction of the CAI program. The tour direct costs included the librarian's time and the instructor's time. The direct costs for the CAI program were attributed to price of the floppy disks, price of software and manual, cost of computer equipment, cost of programmer per hour, cost of lab assistant and maintenance of equipment.

Three models were developed from which to draw analyses. Each model featured the same projected costs for providing tours, which included the librarian's and teaching faculty's time. The differences in the projected costs in each model appeared when designing the costs for producing and maintaining the CAI program. For example, the first model's CAI costs did not include the purchase of computer equipment or a service agreement. The second models' CAI costs did not include the purchase of computer equipment. The third model's CAI costs included everything previously indicated in addition to the purchase of computer equipment.

The cost models' projected outcome shows that there is an apparent difference in the cost comparison of the CAI program and the tour in the first two models from the very beginning. However, with the addition of the purchase of computer equipment the third model does not prove to be cost effective until several years have elapsed. This is due to the cost of the CAI program remaining virtually stable after the initial cost of the purchase of the equipment, while the cost for providing tours increases significantly each year.

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Selected Formal Papers from the

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COMPUTER ANXIETY AMONG TEACHERS IN A COMPUTER LITERACY COURSE

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Abstract

The purpose of the study was to examine the relationships among teacher anxiety, achievement, and sequence of topics in an introductory computer literacy course. The subjects were elementary and secondary teachers who voluntarily enrolled in a university computer literacy course. The subjects were randomly assigned to two groups; there were 19 subjects in Group A and 22 subjects in Group B. The two groups of subjects were exposed to each of three computer-related topics. The sequence of the topics was varied in the two groups. The sequence of topics for Group A was 1) use of tool software, 2) use and evaluation of Computer Assisted Instruction (CAI), and 3) programming in BASIC. For Group B the second and third topics were reversed in order.

State anxiety was measured by the State Trait Anxiety Inventory six times during the study. To measure cognitive achievement, a cognitive test containing 10 questions on each of the 3 topics was administered as a pretest, posttest. Perceived value of hands-on experiences was measured three times, once for each of the three topics, by a Topic Questionnaire.

Results of statistical analyses indicated that:

- there was a significant relationship between state anxiety during specific topic instruction and the sequence of topics;
- the overall decrease in state anxiety for Group B was significantly greater than the overall decrease for Group A;
- here was no significant relationship between overall state anxiety change and overall cognitive achievement;
- only the negative correlation between perceived value of training in the use of CAI and anxiety level for Group A was significant; and,
- there was no significant relationship between cognitive achievement and the sequence of topics.

Of the two topic sequences studied, the sequence in which programming in BASIC was taught as the second topic was better for reducing computer anxiety. There was no optimal sequence for greater cognitive achievement. There was no general relationship between anxiety level and perceived value of training. More research must be conducted using all possible variations of topic sequence to determine if there is an optimal sequence for greater reduction in anxiety and greater cognitive achievement.

Introduction

In order for the computer to play a greater role in preparing students to live and compete in this technological age, schools must adapt with instructional changes. There is "almost unanimous consensus that things must change. Most educators believe that the new tools of the information age can be pivotal in shaping the American classroom to fit its ever-changing environment" (*Power On!*, 1988, p. 201).

In order for computer technology to have an impact on learning, teachers must be comfortable with computers and see them as tools that enhance daily teaching. For this, teachers need training (*Power On!*, 1988). More than eight years after the first microcomputers started being used in the schools, teacher training continues to be one of the most crucial components to the success of any educational technology program (Chaffin, 1988). As the Alaska Department of Education points out in *Electronic Learning's* 1988 Survey of the States, "teacher training is necessary to implement any major instructional change" (Chaffin, 1988, p. 45).

Although state support for teacher inservice training in the use of computers has been increasing over the years (Bruder, 1988), the majority of teachers have received little training. The report of the Office of Technology Assessment (Power On!, 1988) indicates that only one-third of all K-12 teachers have 10 hours of inservice computer training. The summary of findings from the NAEP report "Computer Competence: The First National Assessment" indicates that most teachers graduated from college when few computer courses were offered"While this lack of formal training in computers does not necessarily disqualify them from performing well, too many teachers make low evaluations of their knowledge and skill" (Bracey, 1988b).

The momentum for computer use in the classroom and inservice training for their use has increased (Bracey, 1988a; Bruder, 1988), but there still remains a certain amount of anxiety about using them"Indeed, there have been times when I thought that the kids were catching anxiety from teachers" (Bracey, 1988, p. 20). The Office of Technology Assessment reports that one of the barriers to use of computers in the classroom is intellectual -- initial fears of using the computer (*Power On!*, 1988). The results of an administrative survey conducted by *Electronic Learning* and reported by Andrew Barbour (1987) indicated that seventeen percent of administrators surveyed cite fear of computers as a major problem facing wider implementation of technology in their school or district (Barbour, 1987).

The report of the Office of Technology Assessment (*Power On!*, 1988) notes that in order for teachers to feel in control, initial fears about using computers may need to be overcome. Once teachers can see that the computer is a tool that can help them do their job and once they feel comfortable in using the computer, they will try to integrate it into their classes. Inservice training must help teachers overcome their anxieties about using computers.

> Inservice training in technology must be sensitive to the concerns or anxieties with which teachers approach the use of technology. Many teachers, especially those who consider themselves "B.C." (before computers) have not yet worked with computers and admit to being "technophobic." Others had early negative computer training experiences. Sometimes programming was emphasized; sometimes the courses tried to cover too much, too fast and have no relevance to their teaching needs. Several factors contribute to a teacher's anxiety about computers; they must be taken seriously as they underlie whether or not a teacher adopts technology. (*Power On!*, 1988, p. 104)

Anxiety is the result of psychological stress. The consequences of anxiety depend on the demands of the situation and are usually negative and debilitating. Anxiety induced by interest and excitement is the main facilitator of constructive behavior and creative living (Izard & Tomkins, 1966). If a person does not experience a certain amount of anxiety, he is likely to be ineffective (Grinker, 1966). But a rise in anxiety level induced by a perceived threat or by the complexity of a situation produces disturbances in performance and inefficiency (Grinker, 1966). Anxiety has a tendency to feed upon itself and become more intense. As a person's ineffectiveness becomes clearer, anxiety mounts (Grinker, 1966).

If teachers are to use computers effectively in the classroom, they must first overcome their anxiety about using the computer. To help teachers overcome this anxiety, one must understand what factors contribute to this anxiety and what experiences will alleviate the anxiety. These factors must be taken into account when planning any program for teacher training in the use of computers (*Power On!*, 1988).

How does subject matter taught in inservice programs affect anxiety? Computer anxiety is situational. Reducing anxiety in one context does not imply that it will not reoccur in another context. If there are changes in anxiety levels brought about by changes in subject matter, anxiety-elevating experiences could be eliminated or, if they must be presented, adjustments could be made in the way they are taught to take into account the anxiety they will produce.

When confronted with a new experience, teachers think first about how it affects them (Bracey, 1988a). Researchers found that teachers in beginning stages of learning had mainly self-centered concerns. The Office of Technology Assessment report (*Power On!*, 1988) indicated that instructors for computer inservice training must keep in mind teachers' special concerns regarding computers when they are planning inservice activities. Is there a relationship between anxiety levels and teachers' concerns about the value of the inservice computer training?

The study reported in this paper investigated the following questions:

1. Is there a difference in teachers' levels of computer anxiety due to sequence of hands-on computer experiences?
2. Is there a difference in teachers' overall cognitive achievement in computer-related topics due to their levels of computer anxiety?
3. Is there a relationship between teachers' computer anxiety and their perceptions of the value of the inservice training to them?
4. Is there a difference in teachers' achievement in computer-related topics due to sequence of hands-on computer experiences?

Review of the Literature

Research studies involving computer anxiety have investigated relationships between computer anxiety and exposure to computers, age, sex, prior experience, and mathematics anxiety .

Exposure to computers. Most studies involving computer anxiety are in agreement that anxiety is reduced with exposure to computers. A typical example is the Honeyman and White (1987) study in which 38 adults enrolled in computer literacy classes were administered the State Trait Anxiety Inventory (STAI) as a pretest, posttest, and midterm test. Results indicated that anxiety levels changed significantly after 30 hours of contact with the computer.

The exposure or "hands-on" experience given to the subjects in the studies includes computer programming, problem solving using commercially produced computer programs, use of tool software, and examination of instructional software. Usually the experience is of one type and not a variety. Computer anxiety is situational so that reducing anxiety in one context does not imply that it will be reduced in another context. The studies cited do not address the question of how anxiety levels might change as topic areas change.

Age. Most studies have found no correlation between age and computer anxiety. A representative study is the study by Raub (1981) who found no linear relationship between computer anxiety and age of undergraduate students enrolled in courses involving instructional use of computers or introductory COBOL.

Results from some of the studies cited must be examined with care. In the study by Raub (1981), for example, the range in ages for subjects was only 17 years to 21 years. It is questionable whether or not this range in age is great enough to determine if there is a correlation between age and computer anxiety.

Sex. The relationship between computer anxiety and sex has been reported with mixed results. For example, Honeyman and White (1987) in their study of change in computer anxiety over time found sex to have no significant correlation with computer anxiety. Jordan and Stoup (1982), however, in a study relating self-reports of fear to several variables, found a significant correlation between sex and computer anxiety.

Results of some of the studies examining the relationship between sex and computer anxiety should be examined more closely. In the study by Jordan and Stroup (1982), no data were given on the number of male and female students enrolled in the experimental group. Subjects in the experimental group were enrolled in a data analysis course in which computers were used. There is a possibility that more men than women were likely to enroll in a data analysis course during that time period. If the subjects voluntarily enrolled in this course in which computers were being used, it is possible that they were less anxious about using a computer than students who enrolled in courses in which computers were not used.

Prior experience. Most studies report a negative correlation between computer anxiety and prior experience. The subjects with less computer experience were generally more anxious. A representative study is the study by Jones and Wall (1985) which found a negative correlation between anxiety scores and computer experience of 127 undergraduate students enrolled in the same computer class.

Math anxiety. Only a few studies have included measurements of math anxiety but those studies do indicate a correlation between math anxiety and computer anxiety. For example, Gressard and Loyd (1987) conducted a study to investigate the effects of mathematics anxiety and sex on computer anxiety using 356 junior high through college aged students. Results indicated a significant amount of variance of computer anxiety was explained by inclusion of mathematics anxiety in the regression equation.

Additional variables. Very few studies have included measurements of cognitive achievement. One study that did examine this variable was conducted by Marcoulides (1988). The subjects were enrolled in a computer information systems course. Cognitive achievement was measured on grades of course assignments. Computer anxiety accounted for 53% of variation in achievement. If the assignments were project or programming type assignments, the objectivity in grading the assignments could be questioned. The location in which the assignments were completed could also be questioned. If assignments were completed at home rather than in the classroom, subjects might have received help with the assignments. For some of the studies, valid and reliable instruments such as the STAI and CAIN were used. For many studies (Jordan & Stroup, 1982; Lindbeck & Dambrot, 1986; Raub, 1981; Dambrot, Watking-Malek, Silling, Marshal, & Garver, 1985), however, anxiety instruments were created specifically for the study. Those instruments might have addressed the questions posed in the study, but the reliability of the instruments can be questioned.

More evaluative research is needed to determine: 1) whether computer anxiety is affected by type of hands-on experiences with computers and if so, how it is affected; 2) whether cognitive achievement is affected by level of computer anxiety; and 3) whether correlations exist between age and computer anxiety, and between sex and computer anxiety.

Design of the Study

The population sampled for this study was one of convenience. The subjects were elementary and secondary teachers who voluntarily enrolled in the Microcomputers in Education courses at Lehigh University for the Fall 1989 semester. This sample was selected because the majority of subjects were computer novices with little or no previous computer experience. The literature on computer anxiety suggested that subjects with little or no computer experience can be expected to exhibit a high level of computer anxiety.

The initial sample for the study consisted of 46 K-12 teachers. The subjects were randomly assigned to two groups, Group A and Group B, each containing 23 subjects. In each group there was one person assigned to each computer allowing for maximum hands-on time for each person. Five subjects withdrew from the literacy course, four within the first two weeks, so that the final sample contained 41 teachers, 19 in Group A and 22 in Group B. In Group A 31.6% of the subjects were male, 68.4% of the subjects were elementary teachers and 15.8% had never used a computer prior to taking the ITEC course. In Group B 18.2% of the subjects were male, 68.2% of the subjects were elementary teachers 40.9% had never used a computer prior to taking the ITEC course.

The same instructor taught both groups to control for error due to personality and difference in teaching style of instructors. The instructor selected to teach the course to the two groups had taught the course for eight semesters and had always received excellent ratings as indicated by the course evaluation forms which were completed by the students at the completion of the course.

Three major topics were taught by the instructor. They were 1) use of tool software, 2) programming in BASIC, and 3) evaluation and use of Computer Assisted Instruction (CAI). Although some time was devoted to other activities such as mandatory testing, discussion of computer ethics, and proposal writing, the majority of time was spent on activities relating to the three major topics. Four consecutive weeks were devoted to the use of tool software, three consecutive weeks to evaluation and use of instructional software, and three consecutive weeks to programming in BASIC.

The sequencing of these three topics was varied in the two groups. Although there are six possible sequences of topics, there were only two groups of subjects available for this study. Therefore, the two sequences of topics which provided clearest contrast in terms of placement of program components were studied. The sequence of topics for Group A was 1) use of tool software, 2) use and evaluation of CAI, and 3) programming in BASIC. The sequence of topics for Group B was 1) use of tool software, 2) programming in BASIC, and 3) use and evaluation of CAI.

Detailed course outlines developed by the instructor were given to the subjects at the first class meeting. The outlines varied only in sequencing of topics. The subjects were told what was required of them at the start of the course, thus avoiding the chance for a change in anxiety level at any testing interval due to anticipation of unknown assignments. Any subject withdrawing from the course was asked to submit a report explaining the reason for the withdrawal.

Subjects were assigned identification numbers randomly by the researcher. This assigned number were used on all tests and forms completed by the subjects. The master list of assigned numbers was maintained by the researcher and was not made available to the instructor. A subject forgetting his assigned number could get that number from the researcher at the beginning of the class period.

Course orientation sessions were held for both groups one week prior to the start of the courses in an environment which contained no computers. Attendance at the orientation sessions was required. At the course orientation sessions subjects were given their assigned identification numbers and the Human Subjects form, the State Trait Anxiety Inventory, and the Subject Questionnaire were administered to each subject.

The State Trait Anxiety Inventory was administered to all students at the start of the first class period and after one hour had elapsed in the twelfth class period. The State portion of the inventory and the Topic Questionnaire were administered to all students after one hour had elapsed in the third, seventh, and tenth class periods. The inventory was administered only six times to all students to control for test/retest error. When subjects are given the same test repeatedly at close intervals of time, they tend to mark the same answers (Sax, 1980).

The STAI was administered by the instructor instead of the researcher to control for possible bias of the researcher. At the start of the first class period, the ITEC cognitive test with additional questions relating to the major topics, the STAI, and the ITEC attitude survey were administered as pretests. Subjects were asked to write their assigned numbers on all tests and forms completed that were related to this study. All forms and tests were placed in designated folders by the students and placed in the researcher's office at the end of the class period by the instructor. The instructor did not see any of the forms and tests completed by the students except for the course evaluation forms. Identifying numbers were removed from the course evaluation forms by the researcher before being given to the instructor.

Prior to administering the STAI during the first class meeting, the instructor read the original directions while the subjects silently followed along. The instructor then reminded the subjects to relate all questions in the state portion of the inventory to the use of computers. Also during the first class a general overview of the course contents was presented. The second through fifth classes were used to instruct subjects in Groups A and B in the use of tool software. After one hour of the third class period had elapsed, the state anxiety portion of the STAI was administered by the instructor to all the subjects. The instructor read the original directions while the subjects followed along. The instructor then reminded the subjects to relate all questions in the state portion of the inventory to the use of computers for tool software.

During the sixth through eighth classes, subjects in Group A received instruction in the evaluation and use of CAI; subjects in Group B received instruction in programming in BASIC. After one hour of the seventh class period had elapsed, the state anxiety portion of the STAI was administered by the instructor to all the subjects. Prior to administering the inventory the instructor read the original directions while the subjects followed along. The instructor reminded subjects in Group A to relate all questions in the state portion of the inventory to the use of computers for evaluation and use of CAI. The instructor reminded subjects in Group B to relate all questions in the state portion of the inventory to the use of computers for programming in BASIC.

The ninth through eleventh classes were used to instruct Group A subjects in programming in BASIC and Group B subjects in the evaluation and use of CAI. After one hour of the tenth class period had elapsed, the state anxiety portion of the STAI was administered to all subjects. Prior to administering the inventory the instructor read the original directions while the subjects followed along. The instructor reminded the subjects in Group A to relate all questions in the state portion of the inventory to the use of computers for programming in BASIC. The instructor reminded subjects in Group B to relate all questions in the state portion of the inventory to use of computers for evaluation and use of CAI. After one hour of the twelfth class had elapsed, the STAI was administered to all subjects as a posttest. Prior to administering the STAI during the twelfth class meeting, the instructor read the original directions while the subjects followed along. The instructor reminded the subjects to relate all questions in the state portion of the inventory to the use of computers.

After taking the state anxiety portion of the STAI during weeks 3, 7, and 10, the subjects were asked to complete the Topic Questionnaire, relating the questionnaire to the topics being taught during those weeks.

During the thirteenth class, the ITEC cognitive test with additional questions relating to the major topics, and the ITEC attitude survey were administered as posttests. The ITEC course evaluation form was also administered to the subjects during the thirteenth class.

During the third, seventh, and tenth class periods for each group, the instructor was audiotaped. The tapes for both groups were compared to determine if the amount of time spent on a topic and the information taught were approximately the same for each group. A time table of activities is given above.

Results

A repeated measures ANOVA was performed to determine whether there was a topic sequence effect on state anxiety. Results indicated that there was a significant relationship between state anxiety during specific topic instruction and the sequence of topics. Results of the analysis are summarized in Table 1.

The pattern of changes in anxiety levels differed for the two sequences. For the time period in which Group B subjects changed from programming in BASIC to evaluating CAI, subjects displayed a significant decrease in state anxiety; during that same time period, subjects in Group A changed from evaluating CAI to programming in BASIC and displayed a significant increase in state anxiety. A graphic comparison of the mean state anxiety scores for each testing period is presented in Figure 1. A one-way ANOVA was performed to determine whether there were significant differences in overall state anxiety change scores between groups. Significant differences were found between the groups in overall change in state anxiety from before the start of the course to week twelve of the course and from week one of the course to week twelve of the course. Results of the analyses are summarized in Tables 2 and 3.

Week	Group A	Group B
0	Orientation session Human Subjects form completed, identification numbers randomly assigned, STAI(S&T) and subject information questionnaire completed.	Same
1	Cognitive pretest (with additional topic items) and attitude pretest mandated by the state completed, STAI (S&T) completed.	Same
2	Instruction - use of tool software.	Same
3	STAI(S) and topic questionnaire completed, instruction - use of tool software.	Same
4	Instruction - use of tool software.	Same
5	Instruction - use of tool software.	Same
6	Instruction - evaluation and use of CAI.	Instruction - programming in BASIC.
7	STAI(S) and topic questionnaire completed. Instruction - evaluation and use of CAI.	STAI(S) and topic questionnaire completed. Instruction - programming in BASIC.
8	Group A: instruction - evaluation and use of CAI.	Instruction - programming in BASIC.
9	Instruction - programming in BASIC.	Instruction - Evaluation and use of CAI.
10	STAI(S) and topic questionnaire completed. Instruction - programming in BASIC.	STAI(S) and topic questionnaire completed. Instruction - evaluation and use of CAI.
11	Instruction - programming in BASIC.	Instruction -evaluation and use of CAI.
12	TAI(S&T) completed, instruction - other topics.	Same
13	Cognitive posttest (with additional topic items), attitude posttest, and course evaluation form mandated by the state completed.	Same

Table 1. Two-Factor Repeated Measures ANOVA — State Anxiety

Source	df	Sum of Squares	Mean Square	*F*	*p*
Groups (A)	1	1364.22	1364.22	3.171	.0828
Subjects within groups	39	16780.44	430.27		
Repeated Measure (B)	5	11849.45	2369.89	24.876	.0001
AB	5	4665.21	933.04	9.794	.0001
B X Subjects within groups	195	18577.01	95.27		

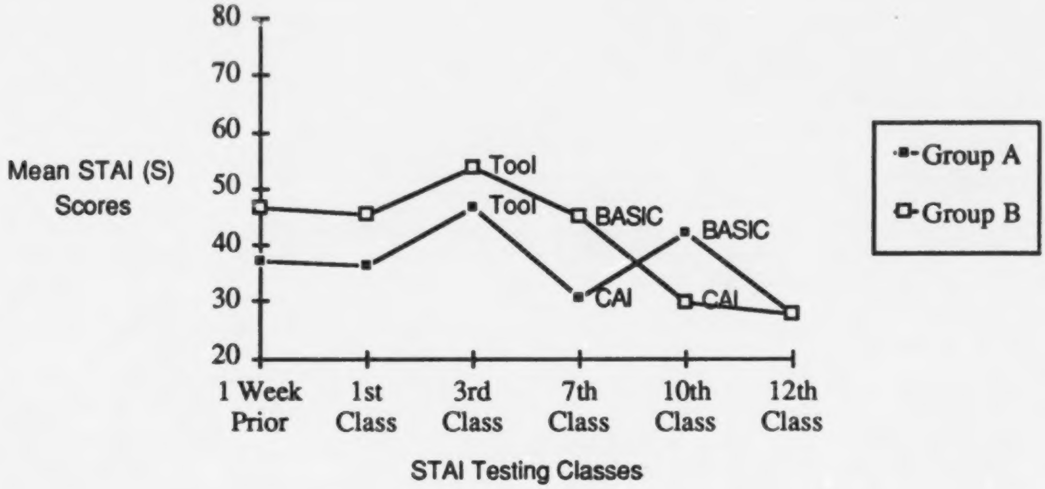

Figure 1. Mean State Anxiety Scores for Each Testing Period. (Range of possible scores is 20 to 80.)

Table 2. ANOVA -- State Anxiety Score Prior to First Class to Twelfth Class

Source	df	Sum of Squares	Mean Square	*F*	*p*
Between groups	1	777.79	777.79	5.104	.0295
Within groups	39	5943.72	152.40		
Total	40	6721.5			

Table 3. ANOVA -- State Anxiety Score First Class to Twelfth Class

Source	df	Sum of Squares	Mean Square	*F*	*p*
Between groups	1	684.88	684.88	4.527	.0397
Within groups	39	5899.61	151.27		
Total	40	6584.49			

In both instances both groups displayed a decrease in state anxiety. However, the decrease in state anxiety for Group B was significantly greater than the decrease for Group A.

An ANCOVA was performed to determine whether overall change in state anxiety had an effect on overall cognitive achievement for topic sequences. Results did not indicate a significant relationship between overall state anxiety change and overall cognitive achievement from either before the start of the course to week twelve of the course or from week one of the course to week twelve of the course. Results of the analyses are summarized in Tables 4 and 5.

Table 4. One-Factor ANCOVA—Overall Change in State Anxiety from One Week Prior to Start of Course to Week Twelve and Overall Cognitive Achievement for Topic Sequences

Source	df	Sum of Squares	Mean Square	*F*	*p*
Group	1	5.22	5.22	.458	.5026
STAI change score	1	.08	.08	.007	.9319
Residual	38	432.98	11.39		

Table 5. One-Factor ANCOVA—Overall Change in State Anxiety from Week One to Week Twelve of Course and Overall Cognitive Achievement for Topic Sequences

Source	df	Sum of Squares	Mean Square	F	p
Group	1	3.63	3.63	.319	.5756
STAI change score	1	.88	.88	.077	.7826
Residual	38	432.18	11.37		

Correlation coefficients were calculated to determine the kind and strength of the relationships between anxiety level and perceived value of training. At the .01 level of significance, only the negative correlation between perceived value of training in the use of CAI and anxiety level for Group A was significant. Results of the analysis are summarized in Table 6.

Table 6. Correlation Coefficients—State Anxiety and Topic Value Quotient

	Group A		Group B	
Topic	r	R^2	r	R^2
BASIC	-.447	.200	.159	.025
CAI	-.623*	.388*	-.084	.007
Tools	-.209	.044	-.059	.003

A repeated measures ANOVA was performed to determine whether there was a topic sequence effect on achievement in each topic area. Results indicated no significant relationship between cognitive achievement and the sequence of topics. Results of the analysis are summarized in Table 7.

Table 7. Two-Factor Repeated Measures ANOVA—Cognitive Achievement by Order of Topic

Source	df	Sum of Squares	Mean Square	F	p
Groups (A)	1	1.81	1.81	.489	.4886
Subjects within groups	39	144.35	3.70		
Repeated Measure (B)	2	8.31	4.15	1.87	.1609
AB	2	8.43	4.22	1.90	.1568
B X subjects within groups	78	173.26	2.22		

Of the two topic sequences studied, the sequence in which programming in BASIC was taught as the second topic was better for reducing computer anxiety than the sequence in which programming in BASIC was taught as the third topic. There was no optimal sequence for greater cognitive achievement. There was no general relationship between anxiety level and perceived value of training. More research must be conducted using all possible variations of topic sequence to determine if there is an optimal sequence for greater reduction in anxiety and greater cognitive achievement.

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INSTRUCTIONAL GROUPWARE: DESIGN CONSIDERATIONS

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The thesis of this paper is rooted in the literature on cooperative learning, group use of computers in instruction and principles of instructional design of educational software. The thesis: that instructional software must be designed to specifications suggested by principles of cooperative learning if the computer is to reach its potential as a tool to facilitate learning in small groups. What follows is a case for the importance of the small group in classroom instruction, a critique of the research on group use of computers in instruction, a derived set of principles of cooperative learning and a framework for the design of computer software which is optimally suited for facilitating small group instructional practice.

A quotation from Joyce and Weil (1986) sets the stage for consideration of the importance of cooperative learning:

> Classrooms organized so that students work in pairs and larger groups, tutor each other and share rewards are characterized by greater mastery of materials than the common individual-study-cum-recitation pattern. Also, shared responsibility and interaction produce more positive feelings toward tasks and toward others, generate better intergroup relations, and result in better self-images for students with histories of poor achievements (p. 216).

Joyce and Weil draw these conclusions based on their own research (Bavja, Showers, and Joyce, 1985 cited in Joyce & Weil, 1986) and on that of others who have investigated what has come to be labeled cooperative learning (Johnson and Johnson, 1984; Robert Slavin, 1983; Shlomo Sharan, 1980).

Cooperative learning practices are those instructional strategies which depend on the interaction of a small group of learners as a central feature of classroom learning tasks. A small group is a "collection of interacting persons with some degree of reciprocal influence over one another" (Schmuck & Schmuck, 1988, p. 20). These persons interact or collaborate with one another and form a consensus of ideas that represents the group as a whole. Specific to education, Bruffee (1984) stated that the purpose of groups in a collaborative learning environment is "to create and maintain a demanding academic environment that makes collaboration--social engagement in intellectual pursuits—a genuine part of students' educational development" (p. 652). As far as Schmuck and Schmuck and Bruffee were concerned, a group should be a fundamental part of learning in most classrooms.

Conventional approaches to instruction which make intentional use of small groups assume face-to-face interaction among students with the teacher serving as a counselor, consultant, critic and one who engineers the discrepant event which motivates group inquiry. Several teaching models presented by Joyce and Weil (1986) are promulgated to promote cooperative learning, ranging from social models such as Group Investigation based on the theories of Thelan (1967) and information processing models such as Concept Attainment and Inductive Thinking.

What is not considered by Joyce and Weil (1986) is an integral role for the computer in the small group process. Conventional wisdom projects use of computers in individualized learning contexts. Yet, there is a fairly extensive literature which supports the notion that group use of computers in the classroom may be a common instructional practice.

Research on Groups Using Computers

Webb conducted numerous studies on small group interaction, initially without considering computer use as a condition. She concluded that:

1. An individual in a group is influenced by the group (1982c),
2. Students learned from their peers (1982b),
3. There was no significant difference between mixed-ability groups and uniform groups (which refuted some earlier studies) (1982a),
4. Students' participation and average frequency of participation within a group tended to remain stable over time (Webb & Cullian, 1983),
5. Student and group behavior, in contrast, tend to be unstable over time (1984b), and
6. Verbal interaction (giving and receiving explanations) promoted learning in small groups if teachers controlled group activities (1985b).

These studies reinforced the theory that small group work is beneficial. But, when Webb studied small groups using computers, the results were not always consistent. Webb (1984a) tried to analyze the "cognitive abilities, cognitive styles, and student demographic characteristics" that make up cooperative group learning (p. 1076). She studied 35 male and female students from ages 11-15 years who were learning to use LOGO programming techniques and analyzed the group processes that occurred during one week. Using a stepwise, multiple regression analysis for student ability characteristics and a partial correlation measure between group interaction variables and computer programming, she found that students working in small groups were successful in learning to use LOGO and that the group-process variables as well as student characteristics and previous experiences, were predictors of programming performance (Webb, 1984a).

In another study, Webb (1985a) focused on the cognitive requirements of learning computer programming with groups and with individuals. She had 30 male and female students aged 11-14 years participate in a ten-lesson workshop learning to program in BASIC. Using a t-test, an analysis of covariance on pretests and posttests, and correlations between student characteristics and programming outcomes, she found no significant difference in the programming outcome between groups and individuals. She concluded that group work did not harm the students, but it did not give beneficial help over individualization (Webb, 1985a).

Webb et al. (1986) conducted another study of small groups engaging in computer programming. This time she dealt with problem-solving strategies in learning to program in BASIC. She used 55 male and female students aged 11-14 years and involved them in a ten-lesson workshop. This time, using frequency of behavior and partial correlations between group interaction and posttest scores, she found that group interaction was beneficial and that students learned and imitated each other's behavior. If the Webb studies were the only ones conducted on group use of computers in instruction, the inconsistency of results would have been a discouragement to further consideration of this topic.

Research on Groups vs. Individuals

Even without the mixed results of Webb's studies, some other studies have proven to be inconclusive. Most of the research cited deals with whether groups work better than do individuals, although some studies also address what type of group interactions are taking place. Karweit and Livingston (1969) tested the hypothesis that students who play a computer game in groups of two or three would perform at least as well as students playing the game alone. They also surmised that the groups of students would be as successful as students working alone. They tested 44 sixth graders with high academic ability in four randomly assigned, sex segregated groups. One group played alone, one group played in pairs, and one group played in threes. The control group did not play the game. The Surfboard Game, developed by Jimmer M. Leonard of the Board of Co-operative Educational Services (BOCES), had students take on the role of a manager of a company. The students had to make managerial decisions about employees and company costs. A test was given after the game to see what was learned.

A two-way analysis of variance was performed on the test, and the results showed no significant difference on learning in any of the group types. Other factors, such as using different machines, also showed no difference in performance. The only difference cited was that boys tended to play the game faster than girls.

Other studies, however, have given more positive results. Trowbridge and Durnin (1984) reported positive results when they conducted a study to see if groups learn better than individuals in a computer environment and whether this learning could be applied to non-computer tasks. Individual interactivity, as a function of group size, was examined by looking at various modes of interaction that students could use while working on the computer. Fifty-eight seventh and eighth graders of middle ability were placed in groups of one, two, three, or four students. The unnamed computer program had students conduct high-level learning activities by manipulating batteries, bulbs, and wires to perform experiments with electricity. Students took a pretest and posttest on their knowledge of electrical circuits. A paper-and-pencil test and an interview were given three months after completion of the program. In addition, students were to apply concepts to non-computer tasks by completing a circuit that lit a flashlight.

An analysis of variance and a mean score for videotaped and audiotaped interactivity across the four types of groups were compiled. Results showed that groups of two to three students work better at the computer than do individuals. Also, these students seem to interpret questions better than do individuals. Groups of four students seem to be too large because one or more members is left-out.

Another study was conducted by Hythecker et al. (1985) to see if students learned better cooperatively at computers than without computers. The authors developed and evaluated a training module derived from computer-assisted instruction and computer assisted cooperative learning (CACL) methodology. This module was used by 89 students at Texas Christian University who were randomly assigned to a CACL group, an individual learning strategy group, or a no-treatment group. The module was devised to teach students how to develop strategies for using MURDER1 and MURDER2 by Dansereau et al. (cited in Hythecker et al., 1985). The training module was used for three, two-hour sessions. The first session was used to assign groups and start the module. The second session was spent working through the training strategies. The third session was used for testing. The CACL group used the module as it was designed, while the individual learning strategy group was given transcripts of the module and told to work individually, and the no-treatment group was told to study the transcripts using whichever study method they preferred.

A two-way analyses of covariance between the Delta Reading Vocabulary Test (for verbal aptitude) and the Group Embedded Figures Test (for text processing performance), was computed. In addition, t-tests were computed on recall of total ideas, main ideas, and detail ideas. Hythecker et al. (1985) found the CACL group to have the best performance over the individualized or on-treatment groups. Subjects in the CACL group concluded that the learning strategies were more beneficial and that they had more personal gain than did subjects in the individualized learning group. The authors stated that this study confirmed that cooperative learning and computer-assisted instruction were compatible learning methods (Hythecker et al., 1985).

Another aspect of group study was studied by Cartwright and Cohen (1977). They investigated the learning and attitudes that students had when working in groups with computers. They used a computer program written in CAN IV that was designed for three sessions of group work in introductory psychology over a one week period. Twenty-eight males and females (education graduate students at McGill University) were randomly assigned to groups of three in three sections. The first section entered all work at the computer individually. The second section discussed answers and entered a consensus answer for the group. The third section discussed answers without reaching a consensus and entered their own answers. An attitude test was given as well as an unannounced criterion test.

Using an analysis of variance on the criterion test showed no significant difference in mean individualized learning scores. However, an analyses of the mean number (by a Scheffe multiple comparison) of correct, incorrect, and unexpected responses did show a significant difference among the three types of groups. The group that gave consensus answers had more correct responses than the other two groups. Cartwright and Cohen (1977) concluded that even though individuals working alone took less time than a group, the total groups within a class took less time to finish a task. Attitudes toward computer instruction were unaffected by this type of learning.

Bellows (1987) conducted a study with younger children using computers and examined task performance and the social interaction of these youth. The ability and sex of 66 second grade students were studied in relation to their achievement on a social studies mapping skill. Ability was designated as reading ability and class ratings by the teacher. In addition, this study also looked at student interactions among the group members.

Three different classrooms were studied containing a total of 28 boys and 27 girls. Students were randomly assigned to groups of two or three. Students were to complete an unnamed computer program on social studies mapping skills and then play an unnamed computer game to determine if they had learned the skills. A pencil-and-paper pretest and posttest were given to the students in addition to the computer programs. Cronbach's Alpha was used to determine internal consistency of the pretest and posttest. An item analysis showed adequate discrimination among test items. Reliability of the pretest and posttest was determined by administering it to 36 second-grade students not involved in the study. Verbal interaction was audiotaped and two observers recorded non-verbal behavior (Bellows, 1987).

Results showed students did learn mapping skills from the computer programs. Sex appeared to have no affect on the achievement of the group members as a result of calculating an analysis of covariance between the pretest and posttest. Students in groups of three had greater achievement gains in mixed-ability groups than uniform ability groups. Non unexpectedly, ability and achievement were significantly correlated. In nine of the 22 groups, one student was dominant, and this student had the highest ability level. Also, five out of six times the dominant student was a male. At times, a group member was excluded from participation by the group. Usually, this was the low-ability student. Students did not usually give or receive explanations, probably because of their limited vocabulary, but they spent a great deal of time with group members reading and copying from the screen. Bellows (1987) concluded that ability is a factor in group interaction and achievement, at least at 2nd grade level.

About the same time as the Bellow's (1987) study, Allen (1988) became concerned that research studies were overlooking the social interaction of students when they worked on computers in small groups. She conducted a study with groups of students in grades four through eight to see exactly what social interactions took place. She started with 39 students in a pilot study that familiarized the students with an unnamed word processing software package and LOGO. A sample of 18 high-ability, male and female students in groups already formed from the pilot study were tested.

The study consisted of three parts: (a) the observation, (b) a questionnaire, and (c) a structured interview. The observation was conducted over a two-month period with each grade level videotaped and audiotaped as they worked at the computers. A total of 10 hours (five separate session for each grade) was recorded. Next, two trained observers viewed and coded the social interaction tapes and characteristics for each of the groups determined during the pilot study as well as the amount of "hands-on" time each student had. The second part, a questionnaire rated by a Likert scale and based on group behaviors and social interactions from the study, was given to the 18 students. Any unrealistic ratings by students were selected for further study. The third part, a videotaped and audiotaped structured interview, consisted of a series of questions to determine why students responded the way they did on the questionnaire (Allen, 1988).

The results showed a great many social interactions (4,127) during the 10 hours of taping. Collaboration was the most frequent interaction, and collaboration increased as the grade level increased. Social talking did occur, but it was often in relation to the task and made up only a small portion of the interactions. A great deal of teacher interactions was included, but this lessened as the grade level rose. There was almost no antagonism, but there were a few incidents of isolation when the students became bored and psychologically withdrew from the group. Allen (1988) concluded that positive social interactions resulted when the students worked in groups with computers and teachers also played an important role. Therefore, using computers in groups in classrooms might be beneficial to both students and teachers.

Yueh and Alessi (1988) believed that students tended to spend more time on group work than in individual work when working with computers. Because of this, they decided to see if a reward structure and ability composition would enhance attitudes toward group computer work. pecifically, Yueh and Alessi (1988) tested to see if groups receiving both individual and group rewards worked better than groups receiving only one type of reward. They also tried to determine if medium-ability students learned more in groups of medium-ability than in groups of mixed-ability.

Seventy junior-high school students from three algebra classes in eastern Iowa were tested. The treatment was randomly assigned because the students could not be. Students took an achievement test with a reliability rating of .86 to determine ability. Class I was rewarded for individual performance, Glass G for group performance, and Class I-G for both types of performance. Within the classes, groups were formed to insure average ability of all group members. Males and females were equally distributed. Twenty groups were formed with an equal number of average-ability and mixed-ability groups in each class (Yueh & Alessi, 1988).

Each group used "Algebra Drill & Practice I for the Apple II" by Detmer and Smullen. The groups were audio-taped for coding analysis later. Each group was to practice using the program and then later a tournament would be held. Students could help each other and took turns answering questions. An unnamed computer game by Yueh was used for the tournament. At the end of the tournament, students received prizes. The group was the unit of analysis. Results showed that Class I-G had higher achievement and more peer tutoring. Combination of individual and group rewards, then, appeared to work best. Ability grouping was inconclusive (Yueh & Alessi, 1988).

Newman et al. (1989) found that using computers in groups helped students and teachers enhance the learning process. They devised a prototype of a sixth grade earth science curriculum that used local area network (LAN) technology. The basis for the curriculum prototype was established practices of cooperative learning groups and inquiry activities. The LAN connected 25 Apple IIe computers to a hard drive which allowed for central storage of group data. The Bank Street Writer word processing software had an electronic mail system added to it and was accessed by the LAN as was The Bank Street Filer. These software packages allowed students and teachers to create databases for access by all participants. Groups were selected by students and as a result became groups of the same sex. Some teachers were in favor of the study, some were reticent. The group study lasted for one year. Students were observed in their group work and in whole-class work. The data that students entered as a group were combined with other groups' data and discussed as a whole (these data-gathering activities were called coordinated investigations).

No statistical measures were taken, but quite a few observations were made. Newman et al. (1989) found that students worked well together. In fact, the groups became quite cohesive. There were some problems with not all students pulling equal weight in the group, and there were times when students wanted to work alone. However, these instances were not the norm. The teachers that had been reticent, as well as other cooperative teachers, started using more small-group activities in other subject areas. The groups were carried over to other subject areas and in other classes. Eventually, the whole school was affected by these small groups. Newman et al. (1989) concluded that cooperative groups were important to the educational process, but they felt individualization could be beneficial. Relevant to this discussion, the authors concluded that software designers and developers needed to design software that played a more supportive role in the small group instructional process.

Problems to Overcome in Research on Using Computers with Small Groups

Results from the studies cited often appear contradictory. For example, Karweit and Livingston (1969) found no difference in group size while Trowbridge and Durnin (1984) found group size made a significant difference. Allen (1988) and Yueh and Alessi (1988) found groups to provide learning impetus for group members while Newman et al. (1989) also found groups to be beneficial and, ultimately, affecting the whole school. However, one similarity that all the studies had in common was that the group was a functioning part of the computer environment and groups caused social interaction among students. The groups may not always have been cooperative as the ones studied by Webb (1984a, 1985a), Webb et al. (1968), and Newman et al. (1989). In fact, they may even have been competitive as shown in the study by Yueh and Alessi (1988). In any event, the research cited above does indicate that groups are an important component in computer work.

Studies need to be conducted within the context of instruction which can reasonably be expected to be productive using cooperative learning strategies. This means that an appropriate choice of teaching model(s) would be drawn from those which have characteristics similar to Group Investigation (Joyce & Weil, 1986; Thelan, 1967). If computer programming is the content domain of the instruction, it would be desirable to use small group process more in the same way that a design group tackles the task of solving a programming problem. Very few major programming efforts are one-person tasks; work groups design, prototype, determine common parameters for proceeding and divide responsibilities for development. This process more closely resembles the type of classroom activity most amenable to cooperative learning practices.

Furthermore, with a few exceptions (Jernstedt, 1983; Newman, 1989), the software used in the studies reviewed was designed for use by one student interacting with the computer as a substitute for the teacher, drill master, or a tutor (Yueh & Alessi, 1988). Many of the inconsistent findings might very well have been eliminated by the development of software better suited to use by small groups.

Computers and Small Groups In Business and Industry

There are those who would argue that at least to some extent school learning environments should mirror the work contexts of the "real world." While this is not the premise upon which most group use of computers in instruction is based nor is it the premise underlying cooperative learning models of teaching as with Group Investigation (Thelan, 1967; Joyce & Weil, 1986), it should be noted that few jobs in today's work world are solitary activities. Groups are a basic part of society. A new trend that is emerging in business and industry is the active collaboration of groups and group members through the use of computers and group-oriented software. This group-oriented software is labelled "groupware" (Tazelaar, 1988; Terry, 1989). It often involves networking between different locations and is used with groups or with individuals sharing information. For example, a document is created and then, via the network, is passed to several people for additions and editing. The concept is not new, but its implementation enhances cooperative group work in the business and industry. This is the same type of computer usage that Newman et al. (1989) studied in their earth-science curriculum.

It would seem that more work with groups in schools is needed to support a practice that is already common in the business world and to reinforce or refute the research already done on groups in schools. As Johnson, Johnson, Holubee, and Roy (1984) succinctly stated, 'We cannot afford to graduate large numbers of students with little or no ability to interact effectively with others--a prime requisite in the world of work" (p. 11). The need is also present to investigate the cooperation of groups working at computers, because computers as well as groups are inevitable parts of the "real world."

If we are willing to accept the assertion that cooperative learning should be encouraged in today's classrooms for at least some types of curricular goals, and if we take seriously the potential of facilitating a very human, face-to-face interactive process with computers, then it becomes essential to look at principles which may undergird the development of software appropriate to the small group environment. It is interesting to note that the successes reported in some studies on group use of computers have been achieved using software developed specifically for single user interfaces which often attempt to emulate the dialog typical of a one-to-one interaction of a student with a teachers. It is only logical that software designed specifically for small group use should engender more success. The principles needed to guide design of software for cooperative learning environments must be derived from a generic set of criteria for successful cooperative learning and from criteria for teacher roles which enhance successful cooperative learning.

Criteria for Successful Cooperative Learning

According to Johnson and Johnson (1984), the most effective of group processes (and the least used) is cooperative learning where students work together to complete shared goals. In order for cooperative learning to be successful, Johnson and Johnson (1984) feel four criteria must be met.

1. *Positive interdependence* must be achieved by group members. Each member must feel good about the role played within the group. Elements of declaring interdependence within the group are
    - Establishing mutual goals (goal interdependence);
    - Dividing labor (task interdependence);
    - Dividing materials, resources, or information among group members (resource interdependence);
    - Assigning students roles (role interdependence); and
    - Giving joint rewards (reward interdependence). (p. 1)
2. Group members must have *face-to-face* interaction. The verbal and non-verbal interactions among group members are equally as important as establishing positive interdependence.
3. Each group member must accept *individual accountability* for completing a portion of the group's work. After all, cooperative learning in schools is used to help each student learn. The group must decide the limitations of each group member and then determine realistically what each member is capable of handing.
4. Group members must use *interpersonal and small group skills appropriately*. The teacher's role in relation to the group is to teach members the limitations and boundaries of the group, acceptable social skills, goal setting, and the skill to analyze progress of the group. Cooperation as opposed to completion is an important group norm which must be learned by participants in the process.

The Teacher's Role for Successful Cooperative Learning

Just as important as the group members establishing their roles and goals, is the role that teachers play throughout the cooperative learning process. Johnson and Johnson (1984) caution teachers that they need to be aware of what is happening in cooperative groups and make sure the learning process is enhanced and not harmed. These authors have set up five teacher strategies to insure beneficial cooperative learning. A sixth has been added by the author of this paper.

1. *Clearly identify the lesson's objectives.* This means not only academic objectives appropriate for the lesson but also objectives incorporating group skills. roup members should clearly understand what is expected of them.
2. *Determine how groups will be constructed.* Several factors should be considered in group construction.
    - *Group Size*: Should groups have two members or up to six? What size is appropriate for the lesson, the time and materials available, and the experience of members working in groups? Johnson and Johnson (1984) suggested that unless group members are experienced in cooperative group work, group size should be no larger than two or three members.
    - *Group ability*: Should homogeneous ability groups or mixed ability groups be used?
    - *Time group members will work together*: Is the lesson appropriate for long term groups or should new groups be made every day.
    - *Room arrangement*: Will group members be able to face each other and talk quietly? Will the teacher have easy access to each group?
    - *Instructional materials*: Should each member have instructional materials or is one copy per group sufficient? Johnson and Johnson (1984) felt that one copy per group is a better way to promote cooperation and collaboration. This way each member receives only the portion necessary to do the job.
    - *Group member roles*: Does each group have a member who summarizes the goals, a member who checks to make sure all other members can answer questions about the goals, a member who checks for mistakes, and a member who can insure that group members can relate the new goals to previously learned goals?
3. *Explain the task and cooperative goal structure.* This strategy requires effective communication on the part of the teacher. The teacher must explain the academic task, the teacher should make sure the group members understand that a group goal must be reached, that they must work collaboratively and with certain desired behaviors, and that each group member is accountable for a certain portion of the group's goal. The teacher should explain whether one product must be produced or whether each individual should produce a product and what evaluation criteria will be used.
4. *Monitor group effectiveness and intervene to provide academic and/or group process assistance.* This is a time when groups should perform the tasks necessary to reach the desired goal. Teachers should monitor carefully, though, to make sure that groups are working cooperatively and that there is some sense of closure when the lesson is completed.
5. *Evaluate group achievement and assess how well members collaborated together.* The quality and quantity of the group product should be evaluated. In addition, group members need to understand if their collaboration was productive. This productive collaboration is most important for future group work.
6. *Emphasize concensus as essential to group success.* In order to produce a worthwhile product, members have to reach some concensus. Concensus is often difficult to reach, but group members learn to support all positions taken and to generate new solutions to problems which may well be different than the solution of any individual member.

Guidelines for Design of Instructional Groupware

What do these principles mean for the design of instructional software, or, to borrow a term from the non-educational software community, the design of instructional groupware? In order to deal with this question it is important to consider the apparent problems with current software design when the resultant software is considered for use in the small group context. In most of the studies cited above, vague references were given to the software. In fact, the software was not even named in four instances, except its type such as drill and practice. The software may play a big role in determining the results of group research with computers.

If the assertion is made that software is important, then who decides what software is good or bad? Fisher (1982) discovered through interviews with research scientists, computer and software manufacturers, educational publishers, and school administrators that the largest group of decision makers about software were the computer and software manufacturers and educational publishers. Disturbingly, he also found that educational publishers felt it was their role to provide computer software to educators, and quite often the software provided was nothing more than a textbook on line. In contrast, computer and software manufacturers produced software, but they frequently were not aware of sound teaching principles. These publishers felt the schools should know enough about computer-assisted instruction to decide whether the software was good or bad (Fisher, 1982).

Fortunately, some of the bad software has disappeared ("The 1988 Classroom," 1988) since Fisher's study (1982). However, the evaluative criteria for identifying good software may still not be sufficiently precise. Becker's (1984) survey stated that work done at computers in schools was done by groups of students rather than individuals. However, in two magazines which summarized the best software of 1988, both overwhelmingly described software that was clearly designed for individual use ("User-friendly," 1988; "The 1988 Classroom," 1988). In "User-friendly Pages" (1988), only two software packages were identified as appropriate for group use out of the 500 described. In "The 1988 Classroom Computer Learning Software Awards" (1988), three of 46 software pages were described as appropriate for group use. Clearly, there is a major difference between the audience for whom the software is being designed and how the software is in fact being used in schools.

In some textbooks that teach instructional software design and development strategies, the emphasis is placed only on individual use. Hannafin and Peck (1988), stated in the beginning of their text that software should be developed for individualized use and their book was based on this premise. Heimler, Cunningham, and Nevard (1987), emphasized the actual writing of code to produce software. However, there was no mention of incorporating cooperative learning in any software examples that the authors used. Ironically, both of these books were written by more than one author. At least two people collaborated to produce each textbook that is intended for individualized software design and development.

What is even more ironic is that most software is designed and developed by more than a single person. For example, Shneiderman (1987), a leader in the field of human-computer interaction, devotes a whole section in his book on assessment of software by groups. He firmly believes that iterative design is an integral part of effective software design. Iterative design, as he explains it, involves developing a prototype and then scrutinizing that prototype to make sure it meets the requirements of its intended audience. This process usually requires the participation of a number of people. One person is not responsible for the entire production of a software interface. Another example of group work to produce software has been done by Good, Spine, Whiteside, and George (1986). They describe the iterative design process used to develop a revised version of a software package used on a VAX machine. The team of authors developed the revisions, and then a group of users scrutinized the revised software.

Designers of instructional groupware should visualize the dynamics of small group process (Thelan, 1967) and the specific role the software under development will play. ontextually, small groups will engage in:

1) collaborative communication (verbal & non-verbal).
2) concensus building within group. Software designers must assume that a concensus building process will be a part of the group process and that individual responses must be negotiated prior to inputting responses to computer (or, if ICAI, that software will not take over the concensus process since this is an essential part of two face to face encounter of small group work.
3) group response to one or more discrepant events. It may be necessary for, the software to first present a discrepant event in such a way as to challenge the group to engage in problem solving behavior, data collection, hypothesis testing and the like. Group inquiry and problem solving are the norm for working groups.
4) hypothesis testing. The software will need to provide feedback at multiple stages of the group process. This will be especially true in the testing of alternate hypotheses proposed by the group. Feedback may need to lay out probable consequences of given hypotheses rather than give the typically "right or wrong" response.
5) a different kind of interaction. This may require extended use of parsing, much as in old "adventure' games to allow user groups to try discovered facts and relationships in the form of positively worded assertions, followed by feedback with new stimuli.
6) extensive record keeping and the organization of reorganization of ideas. The computer is ideally suited to facilitate this task, but structure of specific software must provide this capability or provide an easy interface with tool software suited to this purpose.

Instructional design principles such as those promulgated generally (Gagné, Briggs & Wager, 1988; Dick & Carey, 1985) and those specifically pertaining to software design (Hannafin & Peck, 1988; Heimler, Cunningham, Nevard, 1987; Shneiderman, 1987) will still be essential for sound approaches to groupware development. However, several factors will confound strict adherence to these principles. Generally, the objectives for instruction conducted within the cooperative learning mode are more process oriented than specific-outcome related. Secondly, to set out to develop groupware assumes a perspective of curriculum which values the process of cooperative learning and the nurturant outcomes which are often more important than the anticipated direct outcomes (Joyce & Weil, 1986). This means that the overall instructional strategy calls for group process, and the software will be used to facilitate this process.

Furthermore, the design phases of formative and summative evaluation may need considerable reconceptualization. Given the perspective of groupware which facilitates a process in which face-to-face interaction occurs among group participants and accommodation to the unpredictability of learning outcomes (Thelan, 1960), outcome measurement seems to be less of a criterion for evaluation than is an observable index of group process variables. The extent of interaction, the quality of that interaction, the perceived commitment of group participants to concensus reached, the amount of live intervention by the teacher to assure fruitful continuation of the small group process are just some of the variables which must be considered as bases for formative and summative evaluation aspects of design. It will be necessary to assume that what individuals learn is primarily a result of the group process. To identify the specific contribution to such learning outcomes of the computer usage and of the specific software used may not be necessary.

Already, a few group-oriented software packages exist. For example, the CACL technique discussed by Jernstedt (1983) seems to be true cooperative learning software. Only an overview was given on how the CACL software actually operated, but if it did do the things Jernstedt (1983) professed, then it would be a beneficial addition to a curriculum. Group members entered their responses to a question, and then the answers and the strategies used to arrive at particular answers were discussed collaboratively by the group. The software allowed time for collaboration before the next question appeared. In fact, the group had to jointly decide when it was appropriate to move to the next question.

The earth science software package with LAN capabilities presented by Newman et al. (1989) also shows great promise for cooperative learning. Not only do groups of students record data into a shared database, but the data collected from the whole class can be manipulated and discussed by each small group. In addition, the whole class can perform a type of consensus by using the information gathered from each of the groups. The electronic mail portion of the software also promotes collaboration between groups, instructors, and group members and is very similar to the concept of "groupware" in the business industry presented by Tazelaar (1988). It sounds as if all aspects of cooperative learning, from small groups to whole class, is possible with this software package.

Two other examples of group software already available are "Story Tree" by scholastic and "The Factory" by Sunburst. With "Story Tree" ("User-friendly," 1988), a team of students produces a story. The story is interactive and according to what the reader uses as input, determines what the next segment of the story will be. "The Factory" (Vockell & van Deusen, 1989) allows a product to be made from specifications given by students. According to Vockell and van Deusen (1989), this software works well with groups because the group members can collaborate on what specifications are best to produce a specific product. Vockell and van Deusen (1989) also suggest using this software as a whole class group project. Small groups can come up with collaborated specifications and the whole class can reach a consensus about the best specifications to use to design a product.

More such examples of groupware are needed. Careful adherence to the principles of cooperative learning and to the practical implications for groupware design alluded to in this paper can provide a good starting point for such development. More importantly, the research on groups using computers: 1) must be redirected to be conducted within the context of curricular situations which dictate small group process; and 2) must use software which has been designed specifically to facilitate cooperative learning. Only then can we hope to see consistency of results from this needed field of research related to instructional design.

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THE EFFECTIVENESS OF THE CAI DRILL DESIGNING ON STUDENTS WITH DIFFERENT LEARNING STYLES

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Abstract

A guiding principle in teaching has been the modelling of humanitarian values through individualized learning environments in which the needs of every learner are addressed. Now, as the methods of artificial intelligence are applied to computer-assisted instruction, the the seemingly improbable dream of truly individualized instruction is becoming a reality through intelligent tutoring systems. The purpose of this study was to examine the effects of different modes of CAI drills and their impacts on learners with varying learning styles.

The sample of this study was consisted of 1303 K7 and K8 students. After initial selection, 40 English vocabulary lessons (20 introductory and 20 advanced) were chosen as stimulus materials for the comparison of drill times (Drill 2, Drill 3, and Drill 4). After completing a learning styles inventory and pilot study, the original sample was reduced to 171 students. Dependent measures consisted of The final test on computers included: Literary and Scientific Aptitudes Test; Keyboard Speed Test; and Drill Practice.

The study produced to the following conclusions: 1) Different durations of drill practice effected independent learners, but had little effect of dependent learners; and 2) Different drill strategies are more effective than others, regardless of learning style. The findings of this study may be useful in CAI drill design. This study was sponsored by the Chinese National Science Council.

Introduction

The development of CAI courseware has traditionally relied primarily on the application of fundamental conceptions of educational psychology. However, traditional instructional design has often neglected to incorporate many of these principles within courseware. In other words, the effectiveness of CAI depends not only on the development of software and hardware, but also on the exploitation of data processing, human cognition, emotion, and skill. Therefore, it is imperative to study the variables effecting CAI courseware design in order to produce software that not only incorporates the principles of sound teaching practice, but also matches the student's aptitude and learning styles or preferences.

Good (1987) observed that the development of ICAI has made the application of more complex and obscure pedagogical conceptions of cognitive science possible. The purpose of individualized ICAI is to provide learners with opportunities for self-improvment (Stabbs & Piddock, 1985). However, to fulfill this function, the courseware must be flexible and be able to adapt to satisfy students with different backgrounds and aptitudes, as well as provide an humane learning environment. A variety of scholars have suggested essential factors that should be considered in ICAI courseware design, including: knowledge bases, student models, pedagogical models, and user interfaces (Dede, 1986); and pedagogical control, learner characteristics, pre-knowledge diagnosis, and learning approach (Jonassen, 1985). Rosenburg (1987) also emphasized the importance of the study of learners characteristics and learning styles.

Table 1. The Designing Factors of ICAI

	Knowledge base	Student model	Pedagogical model	User interface
Courseware designing	Sequencing knowledge (declarative/ procedural) (rule base/case base)		Planning Designing Prediction Control	
Cognitive psychology	Linguistic ambiguities (omitted words) (metaphor) (inferencing referencing)	Error pattern I.Q., Interest Learning style, etc.	Diagnosis Monitoring Debugging	
Human factor		Student learning (human factor, ergonomics)	Environment	
Software/ hardware				Voice & Image Input & output

Combining the theories of both Jonassen and Rosenburg, the indispensable factors in ICAI courseware designing could be classified into the categories shown in Table 1.

In the student model, the study of the student's learning style, modelled closely after cognitive psychology principles, could enable ICAI courseware to meet the student's individual needs.As the preceding analysis revealed, the study of the student's learning style is a prerequisite in designing effective ICAI courseware. The objective of this study was to examine the interaction between different learning styles and different ICAI pedagogical models.

Purpose

The major guiding principle of modern humanitarian education is to regard the student as the central concern and guide the student through the process of learning. Therefore, the student's aptitude, interests, and learning style must be all taken into consideration. Similarly, in order to match the student's aptitude, interests, and learning style to the instruction in a CAI environment, it is necessary to examine the degree to which different CAI models account for learning style effects This study concentrated on exploring the various learning responses and achievements of students with different learning style in several CAI drill models.

Research Questions

The first part of this study focused on the frequency of drill repetitions. Since the purpose of a drill is to increase learning effectiveness through repeated practice based on a stimulus-response theory of behaviorism, the frequency of repetition should have a direct effect on achievement (Skinner, 1986). The study included the following research independent variables: the student's literary or scientific aptitude, the basic speed of operating keyboard, and learning styles. Moderator variables included: the ofrequency of drill and the difficulty of the teaching materials. The dependent variables was a measure of learning achievement.

Hypotheses

According to the research questions above, the four null-hypotheses of this study were constructed as follows:

- Ho_1: There is no significant difference in learning among students with different learning styles under different frequencies of drill practice.
- Ho_2: There is no significant difference in learning achievement among students with different learning aptitudes.
- Ho_3: There is no significant difference in response time among students with different learning styles under different frequencies of times drill practice.
- Ho_4: There is no significant difference in error rate among students with different learning styles under different number frequencies of drill practice.

Review of the Literature

Many scholars have defined the concept of learning style and proposed different criteria for classifying learning styles. These criteria include: teaching style, classroom administration, development of individual cognition, development of individual emotion, individual temperament, etc. Witkin (1976) observed that, during the process of learning, the interaction between the learner and the learning environment can have dramatic effects on learning. Consequently, he proposed two overarching learning styles: field-dependent and field-independent.

Witkin's classification schema has been applied in many studies related to CAI. Smith's (1985) study of microcomputer-assisted instruction, for example, concluded that field-independent learners were more compatible with the individualized teaching environment of CAI. This viewpoint was further emphasized in Post's (1985) study. Cosky (1980) suggested a relationship between cognitive style and CAI. Specifically, he noted that field dependence, even more that inteelligence, was the key factor to consider in matching learner's with appropriiate lesson designs. In studying the effects of learning style on CAI in nursing education, Ludwing (1986) pointed out that learning style in different CAI courses had a considerable influence on the learning attitude of learners of different ages. Moreover, using a three-tier classification scheme for learning style (auditive, tactile, and visual) Martini (1986) concluded the tactile learning style is most compatible with conventional CAI programs. He also emphasized that the compatibility between learning style and teaching program might have a critical effect on the attitude and achievement. Massoumian-Zava (1986) studied the achievement of learners' with different learning styles under conditions of various types of feedback and concluded that field-dependent learners are best suited to affective-informative feedback style.

As the literature shows, learning style has indeed been an important element in the efficacy of CAI courseware.

Method

Sample. The sample for this study was drawn from 1303 k7 and k8 students. They were administered a computer-based version of Witkin's *Embeded Figure Test*, which included 32 figures. Students were classified as field-independent as field dependent. From the overall sample, 171 students were selected for further study.

Materials. This study used the frequency of drill repetition to analyze the diversity in learning style, Following the work of Dennis and Kansky (1984), the frequencies of drill repetition selected for this study were two (Drill 2), three (Drill 3), and four (Drill 4) times. To avoid memory effects, new content material was selected for each of the drills as follows. 57 English words were selected from dictionaries. Words with 5 letters are regarded as "easy," and those with 9 letters difficult vocabulary (Miller, 1967). The 57 words were piloted with 50 freshmen and sophomores familiar terms were eliminated from the list. The remainining words with their Chinese explanations were then piloted with 25 seventh and eighth-grade junior high students, resulting in the elimination of 10 additional terms. Therefore, the final lesson content was composed of 40 terms and definitions, 20 easy and 20 difficult.

Dependent Measures. This study used Witkin's *Embeded Figure Test* of field-dependence/field-independence to evaluate the result of the experiment. This study used descriptive and comparative methods to address the following three issues:

The test of learning style: 1303 examinees, including 668 males and 635 females were tested by the *Embeded Figure Test* of learning style. The results showed that the average score of males was 5.53 (SD=5.96), the average score of females was 4.83 (SD=5.53).

Length of the lesson segments: According to the result of the *Endedded Figure Test*, 120 students whose average score was between 3 and 7 points were divided into 6 groups to complete the drill lesson. Each group's answers to the questions were recorded during a 20 minute interval, and the result of this pilot study indicated that the number of questions should be set at 11 for Drill 2, 9 for Drill 3, 7 for Drill 4.

The final tests: After the number of questions was determined, 171 students were tested by the following three kinds of final tests: a) Literary and Scientific Aptitudes Test; b) Speed Test of Operating Keyboard; c) Drill Testing.

Findings

Tested by various statistical methods, such asData from this study were analyzed through One-Way/Two-Way-ANOVAs, and t-tests. The study led to the following results:

There was a significant difference in learning achievement field independent learners under different frequencies of drill practice (F=6.396, p<.05). Specifically, field independents performed better on shorter drills (Drills 3 and 4) that longer drills (Drill 2).

Students with a literary aptitude and those with a scientific one showed no significant difference in learning achievement (t=1.48, p>.05) and different levels of scientific aptitude had no significant influence on the students' achievement (t= -1.71, p>.05).3), nor did different levels of literary aptitude (t= 0.86, p>.05).

Under different frequencies of drill repetition, students with different learning styles showed no significant difference in response time. Variations in drill frequency also failed to produce significant response time effects.

Results of this study also indicate that students with different learning styles show a considerable difference in error rate (F=8.744, p>.05), with filed independent learners outperforming field dependent learners. Moreover, the error rates tend to increase with the length of the drill.

Conclusion

The results of this study suggest the following points for future design of CAI drill-based lessons: Moderate length drill exercises should be used with field-independent learning styles to attain a better learning effectiveness. Longer drills may not only be ineffective, but may cause a decrease in learning due to boredom or other factors.

The frequency of drill repetion seems to have little effect on students with a field-dependent learning styles. Therefore, in designing CAI drill for field-dependent students, for the sake of lesson efficiency, designers should also limit the length of drill lessons to their minimum effective length.

Overall, the results of this study suggest that drill-based lesssons can be an effective means of teaching learners of varying learning style. However, these results also indicate that, once ooverlearning has occurred, the drill should be terminated to avoid a decrease in the overall lesson efficacy.

These results again highlight the tremendous pedagogical importance of adaptive, intelligent tutoring systems that can effectively learn from learners and moderate the lesson according to learner characteristics. These systems hold much promise for promoting the dream of truly individualized, humane learning systems.

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CREATIVE APPROACHES TO KNOWLEDGE TRANSFER

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The purpose of training is to improve on-the-job performance. Most trainers assume that their students will be able to transfer the skills and knowledge learned in the classroom to the workplace. However, there is considerable evidence that less than ten percent of training expenditures pay off in actual behavior changes on the job. Much of what is learned in the training environment can only be applied to problems or events similar to those encountered in training. Equally disturbing is the fact that many training environments do provide the skills and opportunities necessary to facilitate transfer, however, the application of these skills is inhibited by the workplace environment. A familiar type of transfer failure would be the manager who masters organizational development skills in the classroom but fails to apply them successfully in the workplace.

A new upsurge in the interest of transfer of training has begun to occur as most organizations tighten budgets and look for ways to reduce organizational spending. Business and industry can no longer afford to invest billions of dollars a year on training only to be disappointed in the resulting on-the-job performance.

Transfer of training principles are urgently needed for training systems that teach complex jobs. The level of complexity for many training tasks requires that training be done in a simulated environment that provides practical experience in the development of efficient and safe skills. The training of military personnel, police officers, and physicians are but a few examples of training where it is less likely that training can be successfully done on-the-job. Consequently what is needed is a better understanding of the issues involved in transfer of learning.

This paper discusses who is responsible for skill performance and transfer, how transfer of training strategies differ from traditional training methods, strategies for the transfer of training, and how technology can be used to enhance transfer.

Who Is Responsible for Skill Performance and Transfer?

There are many people involved with facilitating the transfer of training to the work environment. The most critical people, however, are the trainer, the trainee, and the manager/supervisor. The trainer must consider the role of the manager in facilitating behavioral changes. Strategies for transfer must therefore begin prior to the training session and must continue after training has been complete. The role of the manager can not be overemphasized in promoting the application of the newly learned knowledge and skills.

How do Transfer of Training Strategies Differ from Traditional Training Methods?

Traditional instructional methods assume that learning is more or less under the control of the instructional treatment. Such methods typically focus on the use of performance objectives that guide the design of the instruction, practice activities, and test questions. The problem does not lie in the use of criterion-based instructional methods, but rather in the way in which the objectives are written. Ineffective training frequently results from the selection and development of performance objectives that do not take transfer and the direct application of knowledge into account. For example, an objective for an instructional design course might be, "The learner will be able to *state* seven characteristics of the adult learner." To better represent the application and transfer of this knowledge the objective should read, "The learner will *design* a training program that incorporates the five principles of adult learning." The difference between the two objectives is that the second requires the learner to use a higher-level skill in the application of the knowledge rather than just the rote recall of information.

Performance objectives that involve logical, systematic, and linear knowledge, such as procedural knowledge, are best suited to behavioral training methods where learning is achieved through rote practice. However, training that involves the application of concepts and principles to previously unencountered situations requires a more creative, intuitive approach where higher-level thinking skills are stimulated. Most performance objectives and their subsequent assessment do not take into consideration the development and use of these higher-level skills and their importance related to the problem solving and transfer of learning.

Recent research has advocated the use of cognitive models that place more direct responsibility for learning in the hands of the student. Cognitive instructional methods take into account individual learning needs and continually adjust to accommodate different learning styles. These methods include the use of accelerated learning techniques, discovery strategies, cooperative learning, and techniques to enhance the development of self-regulatory, metacognitive skills.

Cognitive strategies encourage students to use previously acquired knowledge and skills to assist with the integration and application of new knowledge. Such models advocate the development of performance objectives that provide for the *application* of newly acquired skills and knowledge through creativity, intuition, discovery, and participative learning experiences. An instructional event under the cognitive model would advocate practice activities where the learner applies the new knowledge to a variety of tasks and where feedback on the correctness of thinking becomes a critical component of the learning process.

Strategies for the Transfer of Training

There are three classifications of strategies for improving the transfer of knowledge: pre-training strategies, training strategies, and post-training strategies.

Pre-Training Strategies. Generally the need for training is determined in a needs analysis or a performance analysis. This preliminary process provides the greatest resource for support in helping to ensure that training will be transferred back to the work environment. This front-end analysis identifies not only performance deficiencies but should also determine performance standards, and identify future needs.

In instructional system design models, the needs analysis is the first step used to identify the performance problems that training is to address. Managers are in the best positions to help identify what these deficiencies are. Throughout the needs analysis process, strategies should be used to encourage management to buy into the training process. At the same time managers should be encouraged to participate in training to help impact employee performance. One methods is to have managers identify problem areas in their work environment. From these problems, case studies can be developed that can be used in training as transfer activities to support the analysis and synthesis of content.

Managers are also in the position to help provide the needed information on performance standards and the identification of future needs. Needs might include expanded work responsibilities, problem solving, and changes in company operation. Each of these areas are critically important to the success of a training program.

Throughout the analysis process there must be continued emphasis on how training can benefit performance, productivity, and profitability. In terms of transfer, nothing is more important than a manager who is supportive and excited about training his employees, and who personally takes responsibility for seeing that his employees are able to implement the newly acquired knowledge and skills. Managers can and should be included in every step of training design, development, delivery, evaluation, and reinforcement.

Training Strategies. Most strategies for improving the effectiveness of training are implemented during the training program. The following are generally accepted as being effective when used during training:

- Providing trainees with performance objectives.
- Involving the trainee in the learning process.
- Providing opportunities for practice and feedback.
- The use of questions.
- The use of case-studies.
- The use of different media.

A paradigm shift is beginning to occur as educators and trainers begin to explore new alternatives to old traditional learning methods. Interest in accelerated learning (AL) is growing throughout the world as companies become interested in learning systems that claim:

- 35-50 percent increase in learning
- 40-66 percent reduction in training time
- Less fatigue for students and instructors at the end of a long day compared to traditional training
- Increase in:
  - motivation to take additional training
  - self-confidence in subject matter
  - overall self-esteem
  - ability to use resources.

There are many different elements to accelerated learning, however, the main shift is from a learning environment that is instructor centered to one that is learner centered. No one element can define accelerated learning. Techniques blend together into a learning environment where there is participation, cooperation, and diversity in learning experiences. Accelerated learning techniques can be classified into three groups: mental, psychological, and physical.

- *MENTAL. We* know that there can be no learning without memory. However, frequently our learning is left behind in the classroom when we fail to effectively encode new knowledge. Accelerated learning techniques include the use of memory aids such as visual associations, imagery, and mind maps to help organize material and improve retention. Techniques are used that stimulate both sides of the brain to encourage whole-brain learning. Knowledge bridges are created between new knowledge and prior knowledge.
- *PSYCHOLOGICAL.* Educational psychologists have over the last few years been more interested in applying theories of how the brain really works to the learning process. Conventional education has assumed that learning would occur with concentration, practice, and feedback. We now are beginning to recognize that each individual has a different learning style and that a variety of learning techniques must be employed to address individual differences.
- *PHYSICAL.* To achieve optimal learning outcomes the learning environment in the accelerated classroom is transformed. Distractions are eliminated, including pictures or images on the walls that are not relevant to the subject being taught. Room decorations are replaced by colorful posters summarizing key points. Subliminal messages on many posters support learning as a positive, enjoyable, and challenging experience. A

very important aspect of this optimal learning environment is providing a break every 10 minutes combined with some physical exercise such as stretching. At breaks, nutritious snacks are served; refined sugar and caffeine is avoided.

Accelerated learning offers a new and refreshing alternative to traditional instructional methods at a critical time when business can no longer afford to waste dollars on ineffective and inefficient training methods.

Post-Training Strategies. Training follow-up is a critical component of knowledge transfer. The manager once again is the key resource to successful implementation of new knowledge and skills. If managers are to be primary reinforcers of training, then they must be informed about the objectives and expected outcome of the training program. Ideally, this process begins in the needs analysis, however, it may need to again be re-emphasized. A well informed manager who supports training will be more likely to offer encouragement to employees to use and implement new practices. The trainer may have to spend time with the manager to discuss how to help reinforce training. One method would be to offer a special workshop for the managers where objectives, outcomes, and implementation issues are discussed.

Another important post-training strategy involves discussion and feedback on implementation practices. One method is to have a three or four week follow-up program where each employee gives a short presentation on his use of the training content. Discussion may focus on how it has helped performance and on problems that may have been encountered. This process provides accountability for the transfer of knowledge and skills to the workplace and is also an effective strategy for post-training review and assessment of training effectiveness.

How can Technology Assist with Transfer?

Learning is a process of discovery. Training that provides opportunities for exploration, experimentation, and the cooperative sharing of ideas facilitates the development of higher-level thinking skills. Such activities encourage the application and understanding of information through analysis, synthesis, and evaluation.

One technology that enhances the development of higher-level skills is computer-based simulations. Students solve problems, learn procedures, observe the results of their chosen actions, and develop an understanding of complex phenomena in a safe and efficient learning environment. What contributes to the power of a simulation to enhance transfer is the "learning by doing" approach in an environment that approximates the real world.

Successful simulations that approximate the real world setting have been developed for complex training where split second decision making can involve life and death situations. These simulations allow the learner to interact with real situations and immediately experience the effects of their actions without dire consequences. For example, medical students can learn to become proficient in medical diagnose through carefully selected case studies where the student selects a treatment in response to physical symptoms and then observes the effect of his or her decision on the patient.

Other less dramatic simulations, called process simulations, are used to inform learners about a process or concept that does not manifest itself visibly. Such simulations can assist with the learning of subject matter in economics or genetics. In an instructional simulation called "Catlab", the student can select physical characteristics of a male and female cat about to mate. The simulation speeds up the process and the student observes the resulting characteristics of the kittens. Through repetitive activities with the simulator, the student eventually begins to understand how genetic laws of inheritance operate.

Other simulators teach a sequence of actions that constitute a procedure. Some procedural simulations, such as the learning of cardiopulmonary resuscitation, may only have one correct sequence of steps. Other procedures, however, may involve one or more possible sequences of steps. The choice of the appropriate sequence depends on the use of higher level skills such as analysis, synthesis, and evaluation to determine the appropriate procedure. An example of this type of simulation would be the training of police officers to handle emergency family disputes.

Still other simulations allow the trainee to explore the effects of his or her actions on the attitudes and behaviors of others in simulated on-the-job problem situations. An example of a situational simulation might be a management problem involving the use of different leadership styles. A company is forced to down-size its training department, how will the manager handle the situation? Different leadership styles will result in the choice of different actions. In each case, feedback in the form of resulting outcomes will be given based on the choice of action. The advantage of this type of training is to allow the manager to experiment with different leadership styles without the penalty of failure.

Summary

Traditional training methods are rapidly becoming obsolete. New approaches and techniques are beginning to surface that promise improvement in the speed, effectiveness, and transfer of learning. Many of these transfer strategies involve a creative approach in that one must re-think the learning process and become more sensitive to the learning needs of the student. New strategies call for an intuitive, creative trainer who can design and develop learning activities where there is cooperation and sharing between managers and trainers, between trainers and students, and between student and student.

The emphasis for future training will be on "*being of service*" to the learner. Effective learning will involve asking the student, "What experiences do you need to learn this content?" The emphasis will no longer be just on content, but rather on learning how to learn, learning how to ask good questions, and learning how to develop higher-level thinking skills.

Trainers must begin to think of creative alternatives to old learning styles. Creativity will be essential in designing a blend of activities for the visual, aural, or the kinesthetic learner. Activities must be created that focus on the development of higher-level skills, problem solving, creativity, and metacognition. Training in the 1990's will offer an exciting challenge for those who are willing to go beyond traditional assumptions and old educational paradigms.

PRE-TRAINING	TRAINING	POST-TRAINING
TRAINER Meet with supervisor/manager to: • Identify desired performance skills. • Identify performance standard. • Identify supervisor's role in support of performing new skill. • Encourage supervisor to work closely with employee. • Familiarize supervisor with course content. • Communicate with supervisor suggested methods for support, reinforcement, or role modeling. • Consider developing employee self-assessment instrument. • Develop any pre-course assignment such as reading or researching of information. • Assess barriers to transfer in the work environment (within employee, supervisor, or organization). SUPERVISOR • Memo to employee indicating managements interest in training as well as resulting on-the-job performance. • Discuss importance of training with employee. EMPLOYEE • Understand the organization's objective for training. • Preliminary reading and/or research on topic.	TRAINER • Find out employee expectations and problem areas to be addressed. • Provide opportunities for interactive dialogue. • Provide opportunities for mental experimentation and creativity. • Provide cooperative learning opportunities. a. Provide problem solving activities where trainees can observe how others draw conclusions and reach solutions. b. Provide exposure to alternative points of view. c. Debrief employee following activity. d. Provide feedback on correctness or incorrectness of thinking. • Use case-studies, role-play situations, simulations, or games. Be sure all activities are structured and have organizational relevance. • Have trainee develop an action plan for implementing new knowledge and skills. • Have trainee work on a real project during training. • Hold a discussion where trainees focus on problems they will have to apply new knowledge and skills to. Discuss anticipated implementation problems. • Provide opportunities for discovery learning • Test for understanding and application of principles.	TRAINER • Follow-up session where discussion centers on what was learned and how it will be applied to job. Include supervisor. • If the time between training and the use of the knowledge and skills is greater than several weeks, then provide refresher session. • Hold a session to discuss how an employee applied the new knowledge and skills. Discuss benefits and any problems. Use this employee as a resource to assist others with implementation. • Provide supervisor with information on how to fulfill role as coach and supporter. • Develop job aids to assist employees with application of new skills. Be sure all performance aids have been approved by the organization. • Post-training questionnaire to assess the strategies most effective in facilitating transfer. SUPERVISOR • Reinforce and support new skills. • Provide safe environment for trying out new skills. • Hold employee accountable for implementing his/her action plan. • Provide feedback on employee's performance and suggest improvements. • Provide opportunities for team support.

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DO ICONS IMPROVE THE USER INTERFACE?

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Abstract

The success of the Macintosh interface has brought with it a deluge of systems featuring iconic interfaces. The appeal of graphical representations often tends to make icon driven systems appear simpler to use than menu based interfaces. As the trend toward iconic interfaces grows, one is led to believe that direct accessibility of objects and actions on a display improves user performance. An exploratory study was conducted by the author to determine how successful users were in learning and using both types of interfaces. Results indicate that the iconic interface has a positive effect on learner performance.

Introduction

A rapidly growing number of users with little or no knowledge of a programming language are using authoring systems to facilitate the development of instructional materials. For this audience, difficulties in learning the system may become a permanent obstruction to their using the computer in a creative way (Solloway, et al.,1982). It is said that the first few hours spent learning a system are the most important in determining further continuation by potential users (Dumais and Landauer, 1982).

Using an authoring system should speed the authoring process, making it easier, faster, and cheaper to create instructional programs by eliminating the need to hire a professional programmer or learn a programming language (MacKnight and Balagopalan, 1988-89). Since specification depends on recognition and not recall (Dumais and Landauer, 1982), both menu based and icon driven authoring system are not supposed to either require special training or an extensive learning time. For that matter, any system designed for users should be easy to learn and use, pleasant to use, and contain the functions users need in their work (Gould and Lewis, 1983).

But Cook and Philipps (1989) found this not to be the case with iconic systems. They describe an excessive learning time required before anything useful can be accomplished as a major drawback of icon systems. Moreover, "lesson functions, " they say, "which are normal part of most lessons may be considerably difficult if not impossible to implement using icon-oriented systems."

Our focus is on how new users interact with menu and icon driven authoring systems. Menus are simply lists of options available to a user in a tree structure, while options under icon driven authoring systems are ever present on the display in the form of icons and pull-down menus. On the face of it, this major difference might suggest that a system which provides direct accessibility is easier to learn and use. Our interest lies in discovering what difficulties new users may have in using these system and determining the source of that difficulty by examining the errors users make.

In this paper, we present the results of an exploratory study in which new users with programming knowledge were asked to create a small instructional program. Our objectives were to examine the errors that new users make and determine if there are significant differences between interfaces. Such a study will have implications for the improvement of training and self-instructional materials.

Design of Experiment

Ten students were recruited as volunteers from the Department of Computers and Electrical Engineering and from the Computing Services Staff of the University of Massachusetts and tested individually. Eight students, ranging in age from 19 to 30 years old, were able to complete both weeks of testing before the summer break. The students had taken from one to seven programming courses for credit. One student had taken one credit course, four had taken two courses and the other three had taken three, four, and seven courses respectively. Four of these students felt that they had a stronger Macintosh orientation, two said they were equally comfortable on either machine and two worked primarily on the IBM.

Learners were blocked, according to their rating of their own strengths in using either a Macintosh or an IBM personal computer on a pre-session questionnaire. Then, they were randomly assigned to begin their learning experience on one or the other machines. Data was tabulated only for the eight students who completed both tests. This left four Macintosh users and four IBM users two of whom were equally adept on the Macintosh. The authoring systems used were an icon driven system which resides only on the Macintosh and a menu based system that runs only on the IBM. These systems were selected because their similarities in functionality permitted us to map our instructional lesson onto the set of tools that each provides.

Each learner received one and a half hours of self-teaching followed by a testing period of equal length. The self-teaching consisted of familiarizing oneself with a description of the computer control keys, the system's hierarchical structure, functionality of icons or menu objects and options, and a set of six step-by-step practice exercises designed to teach learners the operations involved under six of ten functional areas in authoring courseware—authoring environment, text creation and editing, graphics editing, animation and instructional strategy(For an in depth description of functional areas and related tasks see MacKnight and Balagopalan, 1989.) These exercises were identical in functions and tasks to those presented in the testing session for each system. Learners were encouraged to complete all exercises before repeating any. At the conclusion of the practice session, learners were given a 15 minute break before beginning the testing session.

The four test exercises, which were identical for each authoring system, included functional areas and tasks frequently performed by authors in developing instructional programs. The first exercise, a cover page, measured ability to import a graphic and use the correct style, font, size of text, and placement. The second exercise was a menu with three items, two of which branched to two other screens and the third branched to the next exercise. The third exercise contained a four item multiple choice question with feedback and branching. The fourth exercise, an animation exercise, required importing a graphic and animating the text.

These exercises measure whether learners understood the function of icons or menu objects and options and mastered the operations practiced in the self-instructional session. Each learner was presented with a script and flowchart of a mock lesson. Since we were not interested in typing skill, typing was kept to a minimum and the use of color was not introduced. The challenge was to produce a brief introductory screen which required importing a graphic, followed by a menu screen, a multiple choice screen, and a closing screen which required an animation, and have the mini lesson function from beginning to end.

Learners were asked to think-aloud, when they were unsure of what to do next. Whenever there was silence during a pause of 15 seconds or longer, the observer asked the learner to verbalize the problem. Upon completing the test, learners were asked to evaluate their own performance in an exit interview and complete an exit questionnaire. One week later, learners repeated the entire procedure, switching authoring systems and using the same exercises, which were now randomly ordered. In this study, the total time that each learner spent in practicing and testing on the two systems was approximately six hours.

Data Collection and Measurement

Data was gathered from a pre-session and two post-session questionnaires—one for each authoring system and a final session interview. Learners were asked to ignore the observer, who sat in the room during the practice and testing sessions. The basic function of the observer was to help if the system went down, to note points of error, which would facilitate documenting errors on the video tape, and to see that learners verbalized any difficulties that they were experiencing. Errors are defined as either failing to select or inappropriately selecting a menu item or icon, cursor, text tool, text font, text style, text size, screen location, content location, screen erase, erase feedback, erase answer, multiple choice format, performance parameters options, object to animate, direction of animation, graphic, branch, and making invalid entries.

Results and Discussion

A small scale exploratory study was designed to determine whether or not new learners with a programming background would be able to distinguish the appropriate context in which to use icons or menu prompts when designing an instructional lesson. Questions asked were:

1. Will new learners, using an icon driven authoring system, do better in comprehension, debugging, or modification than learners using a menu based authoring system?
2. Will learner satisfaction be significantly different between those using icon and menu authoring systems?

Results were recorded through objective performance measures, session videotapes, questionnaires and interviews. Each individual's total score for week one was subtracted from his or her total score received in week two over all factors (total time excluding debugging time, total time including debugging, total errors transcribed from the videotape excluding debugging, and total errors in the hard copy of their program after debugging.) A Mann Whitney U Test was used for comparing scores.

As Table 1 and Table 2 indicate the effect of interface style was significant at the $p <.05$ level of confidence. When debugging time was subtracted, iconic system learners out performed menu system learners, spending less time and making fewer errors in completing the exercises.

These results are in contrast with those of Whiteside and colleagues (1985). In comparing seven user interfaces on a benchmark file manipulation task, they found that new users performed better on the command and menu system than they did on iconic systems. For system users, there were no statistical significant differences between iconic systems and other systems. However, user performance was based strictly on rate of task completion. It is interesting to note that when we applied their formula to our time data before debugging, our results still obtain, contradicting their findings.

Other factor, such as total time, including time spent debugging the exercises and errors detected in the hard copy of their program after debugging, did not reached statistical significance. The pattern of differences indicated a slightly lower score for the icon over the menu group. See Tables 3 and 4.

Table 1. Time in minutes to complete all exercise without debugging.

Subjects	Menu	Icon	Change Scores
1	73	50	23
2	72	42	30
3	35	25	10
4	59	25	34
5	40	38	2
6	84	49	35
7	49	28	21
8	59	41	18

Mann-Whitney U test of difference between menu and icon: Menu Group = 4.50; Icon Group = 0.00; U = 0.00; z = -2.5205; p = .0117.

Table 2. Total errors made in all exercises on videotape.

Subjects	Menu	Icon	Change Scores
1	56	42	14
2	59	32	27
3	28	21	-7
4	76	16	60
5	45	28	17
6	73	35	38
7	44	43	1
8	49	55	-6

Mann-Whitney U test of difference between menu and icon: Menu Group = 4.86; Icon Group = 2.50; U = 0.00; z = 2.2404; p = .0251

Table 3. Time in minutes to complete all exercise with debugging.

Subjects	Menu	Icon	Change Scores
1	76	96	-20
2	72	42	30
3	41	44	-3
4	59	35	24
5	91	71	20
6	93	83	10
7	60	43	17
8	62	81	-19

Mann-Whitney U test of difference between menu and icon: Menu Group = 5.10; Icon Group = 3.50; U = 0.00; z = 1.0502; p = .2936 two-tailed.

Table 4. Errors made in program hard copy after debugging.

Subjects	Menu	Icon	Change Scores
1	28	11	17
2	28	28	0
3	16	8	8
4	42	11	31
5	12	08	4
6	29	06	23
7	13	07	6
8	23	30	-7

Mann-Whitney U test of difference between menu and icon: Menu Group = 4.17; Icon Group = 3.00; U = 0.00; z = -1.859; p = .0630 two-tailed

Both interface style and order of interface style introduction impacted on time needed to complete the exercises, and the number of errors made before debugging. In general, new users found the icon interface easier to use than the menu based system. There are several possible explanations for these findings. The graphical user interface of the icon system allowed users to know where they were, what options were available, and to quickly correct a wrong choice. In contrast, the menu driven system required more back and forth movement among menus and more steps to complete tasks--all of which added to the total time spent in completing the instructional lesson and increased the chances of making errors.

When debugging time was added to the total time, the small difference between interface styles was insignificant. There were many possible contributing factors for this finding. First, the icon authoring system contains a better debugger than the menu based system and people used it. In contrast, two people simply did not use the debugging facility on the menu driven system. Second, the learner approach to the software was distinctively different. On the Macintosh the learning approach was more by trial and error with the learner engaged in debugging almost from the start. This type of approach, however, is inappropriate for learning a menu based system where the learner risks getting lost in the different levels of menus.

The results of the exit questionnaires administered at the conclusion of each testing session produced no difference between groups in terms of learner satisfaction. However, there were differences reported in ease of use and difficulty experienced in using the systems (See Tables 5 and 6).

Table 5. Difficulty in using the system.

	Menu	Icon
Definitely Agree	2	3
Inclined to Agree	4	2
Inclined to Disagree	1	3
Definitely Disagree	1	0

Sample Size = 8

Table 6. I learned this system easily.

	Menu	Icon
Yes	7	3
No	1	5

Approximately three fourths (6/8) of the menu and icon learners said that they learned the authoring system easily. But 7/8 said they had difficulty in using the menu system, while only 3/8 said they had trouble in using the icon driven system. Their perceptions correlate well with their performance measures, thus lending some additional support.

Some of the difficulties learners mentioned in using the menu driven system were related to editing text, lack of good error detection, graphics manipulation, branching, and links between menus. Icon learners listed these items as those being the cause of certain difficulties: confusing submenus , icons taking up too much screen space, lack of on-line help, lack of error messages, the different erase options and not fully understanding the wait and erase icons and the function of the map icon. A detailed account of errors will be reported elsewhere.

Summary

If new users are to continue using an authoring system, they must be able to achieve a level of learning that is encouraging. Often the practice examples in manuals fail to bridge the gap between what the author of the manual thinks a person must learn, and in what order, and what the new user needs to know in order to survive. Frequently, manuals are most useful after the user has some degree of proficiency in using the system. To facilitate learning, we need to know where learners make errors and why. With this understanding we can begin to orchestrate training programs and self-instructional materials that make a difference.

In this paper we have examined whether a style of interface makes a difference in user performance. We found that it does. We have learned only that the menu style of interface presents more of a challenge for new users to learn and use. Clearly, we don't know whether this will hold true over a longer period of time, with different users, or when lesson size dramatically increases.

From this study, we have, however, learned that it is possible to train students to perform tasks that are important parts of instructional lessons in a much shorter time than in the past. Constructing detailed scripts, showing how key tasks should be performed with the new authoring system, proved to be a successful method of learning the system.

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MICROCOMPUTER-BASED INSTRUCTIONAL SIMULATION FOR TRAINING RESEARCH

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Microcomputer-based instructional simulation (MBIS) is becoming more valuable for training and training research in military and civilian settings. In the last two decades, advances in hardware and software technology have made it possible to develop high-fidelity simulators (e. g., pilot training simulators that resemble a real aircraft and provide complex motion and visual cues). However, high-fidelity simulation, which requires mainframe computers and large, expensive facilities, are usually designed for the purpose of precisely reproducing the system being simulated (e. g., F-16 aircraft) rather than for training and research needs. The nature of the hardware and software components of high-fidelity simulators make them somewhat impractical to use as training research vehicles. The costs encountered in changing system configurations to produce only a few experimental treatments can easily outweigh the value of knowledge that is expected to be gained in conducting the research. Microcomputers are usually incapable of producing high-fidelity simulations, but they are often a better choice for conducting training research than mainframe simulators because of their low cost and flexibility for manipulating instructional variables and data capture procedures. Simulations are used for various types of training (e. g., transportation systems, nuclear reactor control rooms, and many other complex systems). Although this report will discuss advantages of MBIS for aircrew training, the theoretical aspects and conclusions are generalizable to other training contexts.

The term, simulator, refers to a computer-based system that is dedicated to simulating a particular device and its environment. The term, MBIS, refers to a microcomputer program without special hardware that can be developed using general purpose programming languages or hypermedia software. Simulators driven by mainframe computers usually have a high degree of fidelity, while MBIS has a somewhat lower level of fidelity. The importance and degree of simulation fidelity to training complex skills such as piloting an aircraft is still poorly understood. Several types of fidelity have been identified (e. g., physical, functional, & psychological). Generally speaking, fidelity refers to the degree that a simulation faithfully reproduces or represents the way a particular phenomena would occur in the real world. For example, full-mission simulators used in Air Force pilot training are very much like real aircraft. The student pilot climbs into the simulator cockpit, takes off, performs various flying maneuvers, and lands. The student uses almost exactly the same knowledge and skills s/he would employ when piloting the real aircraft even though the simulator remains mounted to the floor throughout the training activity. Although the view displayed in the cockpit window is obviously not that of the real world, and some aspects of flight are missing (e. g., G-force), the motion and visual cues are quite convincing and make students "feel" as though they are actually flying. For this reason, full-mission simulators are referred to as high-fidelity simulators.

Unfortunately, full-mission simulators are not effective training devices for teaching entry level skills (Andrews, 1988; Boreham, 1985). Entry-level learners can be overwhelmed by the complexity of piloting an aircraft due to the many instruments to monitor and the large number of decisions to make in a relatively short time. Microcomputers present a much less intimidating interface with the training activity for entry level learners. Low-fidelity MBIS represents a radical departure from the real world task but have been shown to be more effective than high-fidelity simulators in some situations (Gagné, 1962). Teaching student pilots how to operate individual instruments is often more effective than exposing them to the entire aircraft at the beginning stages of training. High-fidelity simulators are good for helping advanced learners integrate/consolidate multiple skills/tasks but are poorly equipped to isolate and train individual skills. Microcomputers can be programmed to simulate various aviation instruments and decision-making tasks and therefore, are quite effective for teaching entry-level skills. MBIS also provides an additional opportunity to deliver instructional treatments and collect performance data for training research purposes. For example, MBIS for Headup and Radar Electro-Optical displays, which are used for navigation and weapons systems, have proven to be effective research and training tools. One important advantage of MBIS is its "stand-alone" qualities. Unlike full-mission simulator training, students can work at improving their skills without the assistance of a simulator operator. Also, because MBIS is based on software rather than hardware components, it can easily be duplicated and run on microcomputers at other locations. This eases scheduling problems commonly encountered when setting up training and research activities. Finally, software can be altered to produce many different types of instructional treatments and capture various kinds of data on floppy or hard disks. Because treatments are designed to operate on a stand-alone basis, different experimental groups or even different experiments can be run simultaneously.

Reigeluth and Schwartz (1989) state that "...few empirically-based prescriptions have been offered to guide the design of instructional simulations." MBIS should not be confused with traditional types of computer-based training (CBT). CBT typically involves instructional materials that are similar to written materials (e. g., presentation of learning objectives, content, practice, and multiple-choice tests) except for the additional branching capabilities made possible by the computer. Although much research has been done using the CBT paradigm, in comparison, there have been very few experimental studies that have examined real-time information processing in the dynamic environment of training simulations. MBIS provides instructional researchers with this capability.

Advantages of MBIS Over High-Fidelity Simulators

Characteristics & Concerns for Conducting Training Research	High-Fidelity Simulators	Low-Fidelity MBIS
Cost of hardware.	very high	very low
Cost of software.	very high	low
Portability of experiments to other locations & across systems.	very low	high
Generalizability of exp. results to other training environments.	low	high
Capability to isolate & manipulate instructional variables & factors that affect learning & performance.	low	high

The use of MBIS to conduct training research will provide an opportunity to examine some important factors that affect the acquisition and retention of knowledge and skills. Simulations have some gaming characteristics that are highly motivating (Orbach, 1979; Ruben & Lederman, 1982). Learners receive information and instruction as active participants in the attempt to control a particular system or environment, and this can be an exciting and enjoyable challenge. Further research needs to be done to identify the factors that make games and simulations fun and facilitate the acquisition of new skills as a function of learners' intrinsic motivation for learning tasks (Deci, & Ryan, 1980; Malone, 1981). Also, strategies used by learners to attend to and encode visual, aural, and symbolic cues need to be explained. Alessi (1988) has suggested that there are optimal levels of simulation fidelity in terms of cost and training effectiveness. Such parameters apparently vary as a function of learners' prior knowledge and the type of task to be learned. The table shown below summarizes the advantages of MBIS over high-fidelity simulators for conducting training research. It is the opinion of the authors that a better understanding of fidelity and other variables that moderate instructional effectiveness of simulations can be attained efficiently through research using MBIS.

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EFFECTS OF ADJUNCT QUESTIONS ON LEARNING FROM HYPERTEXT

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Abstract

An experiment was conducted to examine whether adjunct questions in various configurations within a hypertext document had any effect on retention of information. Results indicated that there were significant differences in retention, with the greatest retention produced by a Read Only treatment with no adjunct questions. Various factors which could account for these findings are discussed.

Recent claims that hypertext will revolutionize the ways that people read and write make the technology appealing to educators (Conklin, 1987; Kerr, 1988; Marchionini & Shneiderman, 1988). Hypertext allows direct interaction with information, leading to rapid and efficient access to further, related information. Readers have unprecedented control over the scope and sequence of what they read, which requires a pragmatic approach to reading based on exploration and conjecture (Stevens, 1986). It has been suggested that hypertext also supports a mode of learning which differs significantly from frame-based computer-assisted instruction (CAI) and model-driven intelligent tutoring systems (Hammond, 1989). To be sure, hypertext is not a panacea for education. There is no guarantee that exposure to vast amounts of information will enhance learning or ensure understanding any more than a library does. But there is some evidence that hypertext environments may be used to create better educational software (Jonassen, 1988; Yankelovich, Meyrowitz, & van Dam, 1985).

While hypertext applications for education are blossoming, research focusing on the efficacy of the technology has not kept pace with development. Users encounter many problems in using hypertext, including getting lost, missing important information due to a poor understanding of document structure, inefficient search strategies, and conflicts between the user interface and the task domain (Conklin, 1987; Hammond, 1989; Jones, 1989; Nelson, 1990; Shneiderman, 1989). Some of these problems are mitigated by creative design of hypertext systems which takes into account the need for learner guidance in specific activities and access strategies (e. g., the Intermedia project described by Yankelovich, Meyrowitz, & van Dam, 1985). But research examining the underlying cognitive processes involved in reading hypertext documents has been minimal.

If we assume that reading is reading, regardless of the medium, then the processes of learning from prose should be similar for hypertext as compared to standard textbooks. A large body of research has examined various instructional techniques which make prose more understandable. One technique which has been shown to be effective is the use of adjunct questions (Rothkopf, 1966; Rothkopf & Bisbicos, 1967). When learners read a passage with the addition of adjunct questions, performance on tests of retention is better than for learners who did not read the adjunct questions. Studies have examined both the placement and the types of adjunct questions. Rothkopf (1966) and Boker (1974) found that both pre questions and post questions enhanced learning, but pre questions tended to inhibit "incidental" learning because the questions cued the reader's attention to information related to the pre questions. Rickards and DiVesta (1974) found that simple rote questions resulted in memorization of unrelated facts, while meaningful questions encouraged the learners to organize material into coherent structures. Mayer (1975) found that performance on a post test of retention was correlated with the type of questions embedded within the text. Learners who read passages with adjunct questions requiring a higher level of cognitive processing also performed well on a test of all other types of questions.

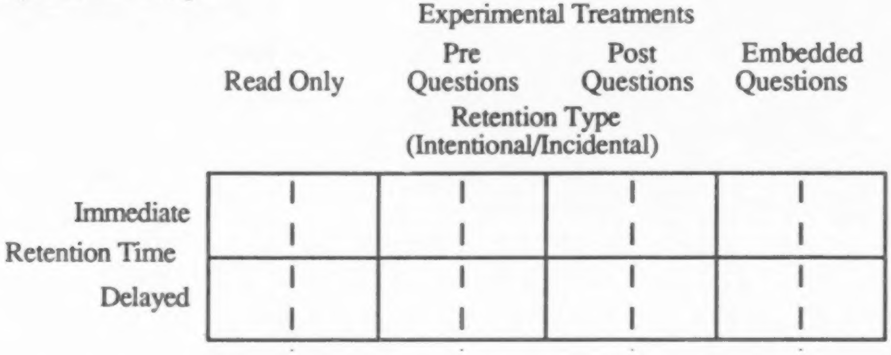
If the placement of adjunct questions are influential in determining what is learned from prose, will the same results occur for hypertext documents? The study reported below examines this question in terms of performance on retention tests. It is hypothesized that results will be similar to previous studies of traditional text, in terms of retention in both intentional and incidental learning. Pre questions should promote better intentional learning, while post questions should promote better incidental learning.

The results of this study may lead to a better understanding of the cognitive processes involved in learning from hypertext, and may help to clarify some of the issues facing designers of hypertext systems. More complete information regarding the cognitive processes and instructional strategies required to use hypertext systems is needed. If the processes and strategies are similar to traditional text, then we may proceed in the design of hypertext learning environments using our current knowledge of how people learn from prose. But if discrepancies in learner performance are discovered with hypertext documents, it may be necessary to further examine the differences between hypertext and traditional text, and revise our instructional strategies accordingly.

Method

Participants. Thirty six participants were randomly selected from a pool of volunteers in educational

Figure 1. Experimental Design.



psychology classes at a midwestern university. Although participation was voluntary, subjects received partial course credit for their involvement in the experiment. The participants were familiar with computers in general (i. e., had used word processors, etc.), but had no experience with hypertext documents.

Design. Because reading hypertext may differ from reading traditional text, due to having to learn both the navigation procedures of the system as well as the content, some control was needed to account for participants' initial unfamiliarity with a hypertext system, and to assess the effects of adjunct questions as participants gained expertise in using the hypertext system. Therefore, a 4x2x2 randomized block design with repeated measures on all factors was implemented in order to examine the effects of growing familiarity with the hypertext system (See Figure 1). Participants each received all four experimental treatments in a random order. The experimental treatments represented different adjunct question strategies (pre questions, post questions, embedded questions and read only) which were employed in a hypertext document. The Pre Question group viewed four questions prior to reading the hypertext section to which the questions related. The Post Question group viewed four questions after reading the related hypertext section. The Embedded Question group viewed four questions interspersed within the text of the related hypertext section. The Read Only group simply read the material without viewing any questions.

Participants completed four sessions, one for each experimental treatment. The other repeated measure factors were retention time and retention type. Retention time represented immediate and delayed retention tests, while retention type represented intentional and incidental retention of information from the hypertext documents.

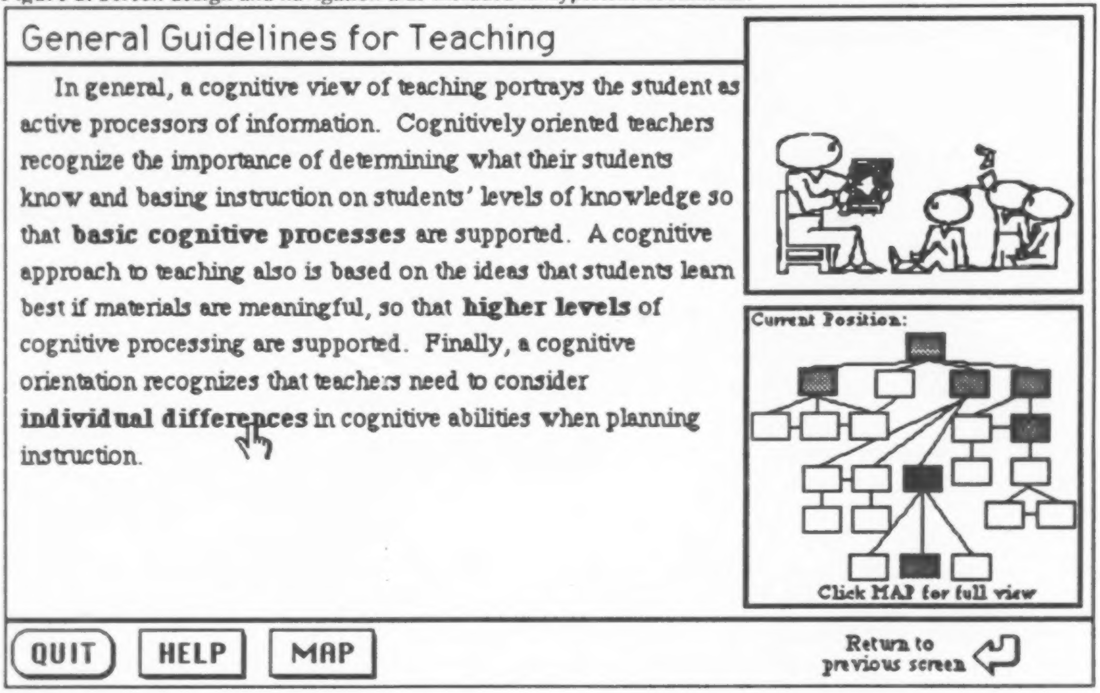
Materials and Equipment. Our hypertext documents which presented concepts associated with educational psychology were developed for use in the experiment. The documents, which ranged from 1110 to 1250 words in length, contained information regarding various aspects of cognitive and behavioral learning theories, cognitive development, measurement and evaluation. The information was adapted from standard undergraduate educational psychology texts (Dembo, 1988; Mayer, 1987), and was delivered using Hypercard on the Macintosh computer.

Information in the documents could be accessed through associative links contained within the text of each screen, with additional links available to a help screen and a full-screen map. Additional navigation aids included a backtracking facility, along with a miniature "map" of the document structure showing the overall organization of the document and the information the user had already viewed (See Figure 2). The software was programmed in order to collect data regarding the time spent on each screen and the sequence of screens accessed by each participant.

One set of eight short-answer retention questions were developed for each of the four documents. Each set of questions contained four intentional questions and four incidental questions. The intentional questions were presented in the hypertext documents and were viewed by the participants in pre, post, or embedded configurations. The incidental questions, based on the content of the hypertext documents, were not seen by the participants until the retention test was given. The sets of retention questions were arranged in a random sequence for presentation to the participants.

Procedure. Participants spent a total of four hours reading the documents over the course of four weeks, in one-hour sessions each week. The sessions were conducted with groups of fifteen participants, each using their own computer. At the first session, participants were given instructions and training on the use of the computer and a small hypertext system (identical in design to the experimental system, but with different content). When they were comfortable with the system, they were informed of the nature of the experiment and given instructions to study the material in preparation for a test. During each session, an experimenter was available to answer questions about the operation of the

Figure 2. Screen design and navigation aids included in hypertext documents.



General Guidelines for Teaching

In general, a cognitive view of teaching portrays the student as active processors of information. Cognitively oriented teachers recognize the importance of determining what their students know and basing instruction on students' levels of knowledge so that **basic cognitive processes** are supported. A cognitive approach to teaching also is based on the ideas that students learn best if materials are meaningful, so that **higher levels** of cognitive processing are supported. Finally, a cognitive orientation recognizes that teachers need to consider **individual differences** in cognitive abilities when planning instruction.

system, but no information related to the content was given. Participants read at their own rates, then completed an immediate test for retention. The same retention test was completed by each participant one week later in order to measure delayed retention.

Results and Discussion

Data included the scores on immediate and delayed retention tests, the amount of time spent reading the documents, and the total number of screens accessed. Analysis of variance (ANOVA) procedures with repeated measures were employed to determine whether differences in mean scores on immediate and delayed tests could be attributed to differences in placement of adjunct questions, if there were any differences in recall of intentional or incidental information, if the total time spent reading varied significantly between groups, and whether the amount of information accessed by participants differed significantly. Analysis of the retention scores was completed in two phases. A key was constructed for the questions, and an experienced rater then compared the ideas from each participant's test to the key, giving one point for each idea which was found in the recall key. A second rater completed a randomly selected subset of the tests using the same scoring procedures. Reliability between the two raters was .91.

Mean total scores for the immediate and delayed retention tests are given in Table 1. A 2(immediate or delayed retention) x 4(total retention score for each treatment) ANOVA with repeated measures showed no significant differences between immediate and delayed retention ($F(1,68)=2.277$, $p<0.136$) and no significant interaction ($F(3,68)=.816$, $p<.4863$), but there were significant differences for retention between treatments ($F(3,68)=2.77$, $p<.0427$). Multiple comparisons using Fischer's LSD procedure revealed that the Read Only treatment produced the greatest delayed retention, and that the Post Questions treatment produced significantly greater delayed retention than the remaining adjunct question treatments. There were no significant differences in immediate retention between the treatments.

Tables 2 and 3 present the intentional and incidental retention scores for each treatment. A 2(immediate or delayed retention) x 2 (incidental or intentional) x 4 (treatment type) ANOVA with repeated measures showed that retention of intentional and incidental information was significantly different ($F(1,140)=7.247$, $p<.008$), but was not influenced significantly by the experimental treatment ($F(3,420)=2.33$, $p<.0735$), or by the type of retention ($F(1,140)=1.331$, $p<.2506$). Multiple comparisons using Fischer's LSD procedure revealed that participants recalled more intentional information than incidental information. Similar comparisons showed that the Read Only treatment produced significantly greater retention on intentional questions for the delayed test than for the immediate test. This difference may have produced the interaction

Table 1. Mean total retention scores for immediate and delayed measures.

	Experimental Treatments							
	Read Only		Pre Questions		Post Questions		Embedded Questions	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Immediate (N=36)	4.40	1.91	4.11	1.87	4.11	1.89	3.91	1.95
Delayed (N=36)	4.03	1.62	3.23	1.64	3.91	1.74	3.43	1.58

Table 2. Mean retention scores for immediate and delayed intentional questions.

	Experimental Treatments							
	Read Only		Pre Questions		Post Questions		Embedded Questions	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Immediate (N=36)	2.31	.95	2.11	1.19	2.28	1.08	2.19	1.14
Delayed (N=36)	2.56	.94	1.83	1.16	2.08	.94	1.94	1.09

Table 3. Mean retention scores for immediate and delayed incidental questions.

	Experimental Treatments							
	Read Only		Pre Questions		Post Questions		Embedded Questions	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Immediate (N=36)	1.75	1.13	2.03	1.05	1.94	1.12	1.83	1.18
Delayed (N=36)	1.89	1.14	1.53	1.03	1.92	1.23	1.64	1.02

between retention type and treatment (F(3,420)=2.991, *p*<.0308) which was revealed by the ANOVA. The amount of time spent reading the hypertext documents was not significantly different between treatments (F(3,68)=1.699, *p*<.1763), however, there was a significant difference in the amount of information accessed in the different treatments (F(3,68)=4.625, *p*<.0055). Multiple comparisons using Fischer's LSD procedure showed that participants in the Pre Questions treatment viewed significantly less information than the other treatments. These results are consistent with the findings of Rothkopf (1966) and Boker (1974), indicating that pre questions tended to inhibit careful reading of all information in the hypertext documents in favor of a focus on information that was related to the pre questions.

In summary, significant differences in retention of information presented in hypertext documents were found, with greater retention for the Read Only treatment than for treatments which included adjunct questions in various configurations. These results are surprising when compared to similar studies of the effects of adjunct questions in text. Differences found in the present study may be due to several factors. First, there is the issue of whether or not adjunct questions are effective for learning from prose, even in traditional text (Lindner & Rickards, 1985). Although effects were found in the original studies (Rothkopf, 1966; Rothkopf & Bisbicos, 1967), those experiments were performed using short passages (50 to 100 words) of unfamiliar information. The information presented in the current study using hypertext documents was at least somewhat familiar and meaningful to the participants, and prior knowledge may have confounded the results of this study. Second, four trials may not be sufficient time for participants to become comfortable and efficient in reading hypertext documents, and the adjunct questions may have influenced their reading habits. This is especially evident with regard to the amount of information accessed in the different treatments. Third, the length of the documents may have contributed to the results of this study. There may have been too much information to read, which interfered with the effectiveness of the adjunct questions, as indicated by the superior retention of the Read Only treatment.

Conclusions

The results of this preliminary study do not rule out the use of adjunct questions in hypertext documents, however, special care should be taken in the placement and number of adjunct questions in hypertext. Problems could arise, especially if adjunct questions are used in a pre question configuration. It may be that adjunct questions could reduce the sense of exploration that is often an important feature of hypertext. Further research is needed to determine some of the other effects of adjunct questions in hypertext documents. This research should focus initially on the placement, number and type of adjunct questions. Since there is no way to predict the sequence in which information will be read, placement of adjunct questions becomes especially difficult. It may not be effective to place adjunct questions on every screen, and the optimal number of adjunct questions per words of text needs to be determined.

Alternatives to adjunct questions and other mathemagenic strategies also need to be explored. It is likely that constructing a hypertext document will result in better retention of information than simply reading a hypertext document. Other strategies, such as note-taking, summarizing, organization, or constructing links should also be investigated. If we are to realize the projected benefits of hypertext in education, we must investigate all possibilities for using hypertext in various instructional situations.

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THE EVALUATION OF INTELLIGENT TUTORING SYSTEMS: A PLAN AND AN EXAMPLE

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Abstract

This paper explores the realm of evaluation within the domain of Intelligent Tutoring Systems (ITS). Toward that end, Littman and Soloway (1988) describe two facets of evaluation that are examined: external and internal evaluation. Described here are a variety of procedures that they did not address and some that they discounted. One of the procedures not explored is the use of Bloom's (1984) "2-Sigma Problem". Anderson, Boyle and Reiser (1985) used this procedure to externally evaluate the Lisp Tutor. Priest and Young (1988) offer a variety of procedures that can be used for internal evaluation. These procedures are presented and POSIT (an ITS for subtraction of whole numbers) is used as an example case to illustrate the evaluation procedures.

There has been a great deal of expectation for the benefits of Intelligent Tutoring Systems (ITS), but there is some equivocating evidence (Stasz, 1988) which does not support large scale expenditures for their implementation. However, researchers are beginning to address the issue of evaluating ITS (Anderson, Boyle, & Reiser, 1985; Littman & Soloway, 1988; Priest & Young 1988). Anderson, et al., (1985) used an approach which pits their ITS against human tutors and a no tutoring condition. Littman and Soloway (1988) suggest that evaluation of ITS has two facets: external and internal evaluation. Priest and Young (1988) present four different ways of evaluating the student model within an ITSI argue here that Anderson's, et al., approach can be cast as one example of external evaluation while Priest and Young's evaluation is an approach to internal evaluation. I describe here these approaches and use POSIT (Orey & Burton, 1990) as a test ITS for the evaluation process. Before I begin the description of this evaluation procedure, it will help to describe the ITS used to demonstrate the procedure. In addition, a short description of the data collection is provided.

Description of POSIT

POSIT is an ITS for the tutoring of whole-number subtraction. The design of this system (see, Orey & Burton, 1990, for a detailed description of the design) is based somewhat on Anderson's (1987) ACT* theory of learning. Within this theoretical orientation, it is assumed that the learning of a cognitive skill builds from declarative knowledge. In terms of subtraction, the algorithm to be learned is made of a set of declarative information. During the development of this skill, this knowledge becomes consolidated into the specific skill (in this case, proficiency with a subtraction algorithm develops). Declarative knowledge is provided to the learner in a text form when errors occur or when the learner asks for help. For example, this is a typical message after making the Error of Omission (see Table 1 for error types) - Decrement (#1 and #2 are variables that are bound during the execution of the program) *"You have to complete the borrow into the ones place by taking away one of the tens. So, the correct value for this area is #1 You typed #2 Please enter the correct value."* Although this is a very brief description of POSIT, it should suffice for the purposes of this paper. It is also necessary to provide a short description of the participants and the method used for the collection of data for this paper.

Table 1. The four error categories and instances of errors in each category (numbers are ranked according to number of occurrences).

Errors of Omission	**Errors of Commission**
1. Increment (add 10)	5. Increment
12. Decrement (subtract 1)	4. Decrement
13. Both	11. Both
7. Neither	

Errors of Creation	**Other Errors**
8. smaller-from-larger	2. Fact error
10. 0-N=N	6. Typing error
90-N=0	3. Leading 0
14. N-N=N	
15. N-N=0 with regrouping from	
16. M-S=0, with S>M	

Data Collection

Twelve participants were used in the evaluation. These participants were about 8 years old. Only those students who were having difficulties in subtraction were used. The selection of these participants was based on their teacher's recommendation and their performance on a subtraction test developed by the DEBUGGY system and reported in Van Lehn (1982). Out of a pool of 28 students who were having difficulties in subtraction, twelve participants were selected, but only ten of these completed the study. The data was collected over a five week period of time where the participants used the system about 30 minutes a day (averaging about 6 hours of total instruction). POSIT saves a great deal of information about each interaction. These data were used to demonstrate the evaluation procedure described here.

Evaluation Procedure

I begin with Littman and Soloway's notion of external evaluation. They suggest that CAI approaches to evaluation have been in terms of achievement testing. That is, groups who received instruction via CAI versus groups who did not are compared by using a pre and post achievement test. The idea is that if the students in the CAI treatment out perform the students that did not, then the CAI is superior to no CAI. Littman and Soloway suggest that since ITS development is embedded in the field of cognitive science, a cognitive science perspective on evaluation would be more fruitful.

By a cognitive science perspective, it is implied that the system attempts to understand the cognitive processes and/or the knowledge structures (states) of the learner. Therefore, the evaluation should follow these lines. That is, the evaluation should focus on how the student is performing some process or how the student has organized some knowledge rather than on a number correct as measured on a typical achievement test. A general achievement test does not get at the level of specificity that an ITS can examine. Hence, learning is viewed as a continuous process and the system would be evaluated in terms of its ability to recognize a learner's current state and how well the learner is helped to progress from the current state to an advanced state.

However, gross analyses are also useful if they are well designed. I would say that much of the content of the ITS can be measured on a test that was developed for the evaluation of the content area of the ITS. The processes that learners are learning from the ITS can manifest themselves both in terms of the actual knowledge and processes, but also in the product of these processes (i.e., answers on an achievement test). Therefore, there should be a distinction made between these two levels of external evaluation. At one level, the ITS is evaluated in terms of the knowledge states and cognitive processes which are a part of the design of the ITS. At the other level, the ITS is evaluated based upon performance on an achievement test specific to the domain of the ITS.

In terms of POSIT, the external evaluation at the first level would be in terms of the specific declarative knowledge (productions) that make up POSIT. Operationally, this means that there should be a reduction in the number of errors that POSIT identifies. That is, POSIT should be helping students eliminate errors in their algorithms. Table 2 shows the number of errors on the first and last days of the field test made by the ten participants that used POSIT. The first result of importance is the fact that there was an overall reduction in the number of errors (from 30 to 13 errors). However, on a cognitive science level, the results indicate that the specific error productions that the participants were using at the beginning of the field test were greatly reduced by the end of the field test. The most pronounced is the least significant -- the leading zero error type. This result is not surprising since the regular classroom teacher taught the students to fill in all spaces, so leading zeros were correct in the classroom. On the other hand, Errors of Omission were nearly as frequent as the leading zero error. This decrease would indicate that the children's procedures were being modified by their having used POSIT. Another approach might be to examine the number of steps that were carried out mentally and the time it takes between steps (this data is available, but not analyzed).

Table 2. The frequency of errors in each error category on the first and last days of the treatment.

Type of Error	First	Last
Errors of Omission		
Increment (add 10)		
Decrement (subtract 1)	11	1
Both		
Neither		1
Errors of Commission		
Increment		1
Decrement	5	1
Both		
Errors of Creation		
smaller-from-larger	1	
0-N=N		
0-N=0	1	
N-N=N		
N-N=0 with regrouping from M-S=0, with S>M		
Other Errors		
Fact error	1	
Typing error	5	2
Leading 0	13	1
Incorrect diag.	6	6

The second form of external evaluation was carried out by using a pre and post test quasi experimental design. There was an overall decrease in the number of errors from the beginning of the experiment to the end (see Orey, 1989). Perhaps a more powerful technique for conducting this form of evaluation is to use the approach that Anderson, et al., (1985) used. That is, Anderson et al., used a procedure that was based on the notion of Bloom's (1984) "2-Sigma" Problem. The "2-Sigma" is the fact that the average student that is tutored scores 2 standard deviations higher than the average student in a large group presentation instructional format. The "problem" is to find a cost effective solution that comes close to the effectiveness of human tutors. Anderson, et al., used three groups to evaluate their Lisp tutor.

One group was tutored by competent human tutors (HT). One group was tutored by the computer tutor (CT). the third group was required to do their programming assignments on their own (NT, which is how assignments are typically completed). The measure was the time it took to complete the assignments. The HT group took the least amount of time (11.4 hours) then the CT group (15 hours) followed by the NT group (26.5 hours). This type of evaluation seems compelling (POSIT is due to be evaluated by this method in the fall of 1990 and data for this approach should be available at the conference), at least for the administrator that is trying to make a decision about implementation. The former is more compelling for the researcher. Therefore, a good evaluation will use both forms of external evaluation.

Internal evaluation, according to Littman and Soloway, is the evaluation of the relationship between the architecture and the behavior of the ITS. The point of this evaluation is to maintain the goals of the tutor as it goes through its many revisions. A somewhat more powerful evaluation procedure was suggested by Priest and Young (1988) which might be used for internal evaluation. This procedure revolves around a cognitive science evaluation procedure in that it evaluates the internal theoretical power of the learner model.

Priest and Young (1988) suggest that there are four measures of the accuracy of the model of the learner. Those four measures are: 1) Percentage correct diagnosis; 2) Error fit measure; 3) Micro-theory evaluation quotient; and, 4) The cumulative hit curve. The first measure is the easiest, but there is no way to determine the true power of the learner model from this value. Internal evaluation, according to Littman and Soloway, is the evaluation of the relationship between the architecture and the behavior of the ITS. The point of this evaluation is to maintain the goals of the tutor as it goes through its many revisions. A somewhat more powerful evaluation procedure was suggested by Priest and Young (1988) which might be used for internal evaluation.

Figure 1. Priest and Young's (1988) four measures of internal theoretical power and their values for POSIT.

1) Percentage correct diagnosis.

$$\frac{\text{Number of correct diagnoses X 100}}{\text{Number of data points}} = \frac{371 \text{ X } 100}{489} = 76\% \text{ for POSIT}$$

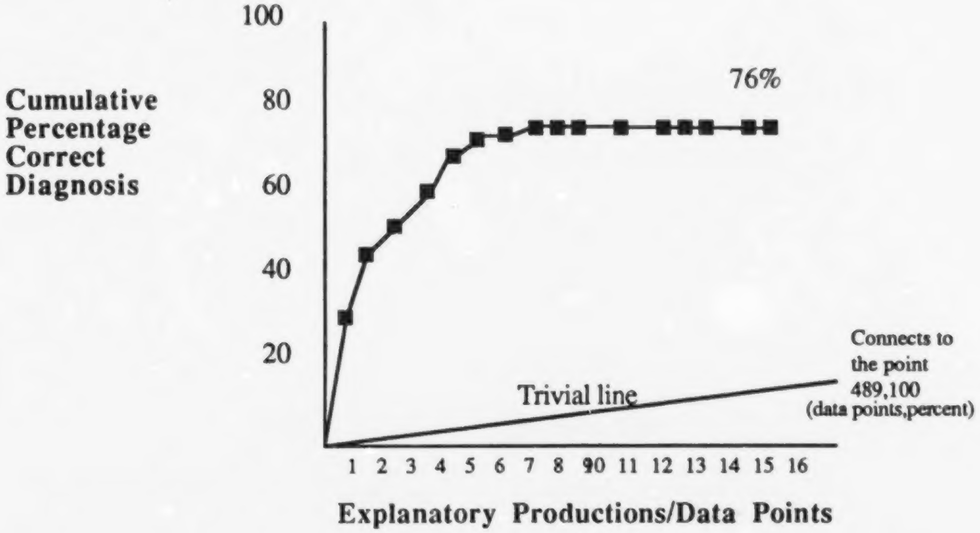
2) Error fit measure.

$$\frac{\text{Number correct diag. - Number wrong predictions}}{\text{Number of data points}} = \frac{371 - 46}{489} = 0.665 \text{ for POSIT}$$

3) Micro-theory evaluation quotient.

$$\mu = \frac{\text{Number correct diag. - Number of productions}}{\text{Number of data points}} = \frac{371 - 16}{489} = 0.726 \text{ for POSIT}$$

4) The cumulative hit curve.



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Afterall, the system may have an unique explanatory production for every error made (Young and Priest refer to this as a trivial case, which theoretically it is, but pragmatically it would be mind boggling to develop such a system). This does not contribute to a theoretical view of learning and therefore is not a powerful theory, yet the percentage correct would be 100 percent. Notice that in Figure 1 POSIT has a percentage correct of 76 percent.

The second measure, the error fit measure, is especially sensitive to false error analyses. Obviously, by subtracting wrong predictions, this value will decrease. The lower the number, the less viable the theory. Notice in Figure 1 that POSIT has a value of 0.665. The third measure specifically addresses the problem of a trivial theory. To ensure that the theory is robust enough, it is necessary to subtract the number of productions (or variant procedures) from the number of correct diagnoses. In this way, each production must be powerful enough to explain many errors or conditions. Perhaps the most powerful of the evaluation methods is the fourth: the cumulative hit curve. This curve plots the percentage of errors explained versus the number of productions used. The straight line represents the trivial case (1 to 1 correspondence between errors and productions). Figure 1 shows the cumulative hit curve for the first stage of evaluation of POSIT.

These evaluation measures help evaluate the theoretical power of a learner model within the ITS. Further, we can judge our progress by showing how the new system out performs the old system. We can use an excepted guideline. However, it is not readily apparent whether POSIT is good or bad based on these numbers. What is needed is for all systems to report these numbers so that an industry standard can be established.

In conclusion, no evaluation procedure is complete without some if not all of the procedures described in this paper. It is quite important to perform evaluations on an ITS both internally and externally. The external evaluation seems to be more important with regards overall instructional effectiveness while the internal evaluation is concerned with theoretical power. ITS affords the opportunity to explore theoretical issues within cognitive science as well as instructional issues within the a cognitive instructional science.

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HOW TO APPLY INTELLIGENT TUTORING DESIGN PRINCIPLES TO THE DESIGN OF COMPUTER-BASED INSTRUCTION

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Abstract

While many have suggested that a cognitive approach to the design of instruction is desirable, little change has occurred in our practice. On the other hand, researchers developing intelligent tutoring systems are using cognitive theory to design learning environments which actually extend our understanding of cognition. This paper describes how some of the cognitive design principles employed in intelligent tutoring systems might be utilized in the design of more traditional computer-based instruction. The end result is that the "new" computer-based instruction will be closer in type to intelligent tutoring systems, where design decisions are made based on a cognitive perspective rather than the more traditional behavioral approach to design and development commonly found in current instructional systems design (ISD) models.

The evolution of instructional systems has passed from teaching machines and programmed texts to computer-based instruction featuring tutorial and drill and practice strategies. Along the way, a systematic process for the design of instructional systems was also developed, prescribing various activities such as needs assessment, development of objectives, selection of strategies, and formative evaluation. Despite differences in outward appearances, all of these instructional systems have been driven by a frame-based approach derived from behavioral theories of human learning. For a variety of reasons, such systems and theories are now seen as largely ineffective for instruction. On the other hand, cognitive psychology has made great progress in describing the structure and processes of human cognition, and has fostered many discussions of the possibilities for improving instruction by relying on cognitive learning theories (Merrill, Li & Jones, 1990a; Hannafin & Rieber, 1989a; Hannafin & Rieber, 1989b; Low, 1980; Salomon, 1985; Wildman, & Burton, 1981; Winn, 1988). Glaser (1989) has noted that while there is still much descriptive theoretical work to be done, cognitive theories need to begin to address the idea of how those structures and processes are acquired. He feels that learning theory and instructional theory can be developed simultaneously, stating that "[t]he study of learning can now take its cue from this knowledge [descriptive theories], and principled investigations of instruction can be a tool of major importance for the interactive growth of learning theory and its applications" (p. 38).

Current instructional design models are founded in behavioral psychology, and do not adequately support the kinds of analysis, design, development, and validation activities which are necessary for designing instruction which supports cognitive conceptions of learning. In order to design a new generation of computer-based instruction which incorporates the principles of cognitive learning theories, new models for the design of computer-based instruction are necessary to guide decision-making. In addition to fitting new ideas into old models, as has been suggested by Park, Perez, & Seidel (1987), and developing a completely new model, as proposed by Merrill, Li, and Jones (1990b), we believe it is more feasible to borrow and adapt a model which has already proven effective. That model is the intelligent tutoring system.

The evolution of intelligent tutoring systems has been based in cognitive science, reflecting the theoretical orientation of cognitive psychology better than much computer-based instruction which features page-turning and limited interaction. Various forms of computer-based instruction are incapable of performing well from a cognitive perspective because the design processes utilized are not conducive to the development of flexible instruction which can adapt to the learner as the instruction occurs. As Winn (1988) has noted, traditional instructional design models require that all decisions about instruction be made and tested before the instruction is implemented. Winn (1989) suggests, therefore, that intelligent tutoring systems may be the instructional medium of the future because of the dynamic cognitive modeling capabilities which allows the system to make adaptive instructional decisions as the learner uses the system. In the following pages, a general model for an intelligent tutoring system is described, along with suggestions for the improvement of computer-based instruction using design principles derived from research in cognitive science.

A Model of an Intelligent Tutoring System

Intelligent tutoring systems derive historically from computer-based instruction, but since there are basic differences in theoretical perspectives, they represent two poles along the spectrum of systems. Differences between the two types of instructional systems are primarily structural characteristics: intelligent tutoring systems encode knowledge, while computer-based instruction encodes instructional decisions based on knowledge (Wenger, 1987). Subject matter is separated from teaching method in an intelligent tutoring system, thereby separating content from presentation techniques (Clancey, 1984). Intelligent tutoring systems are based on the idea that natural learning occurs through context-based performance, with the goal of research being to develop programs which understand student misconceptions and behave as a master teacher would to provide appropriate instruction (Loser & Kurtz, 1989). Because of the architecture of the software, intelligent tutoring systems allow comparisons between learner behavior and an expert model in order to provide the appropriate instructional activities, just as a teacher would.

The main advantage of the intelligent tutoring systems model, however, is that the underlying assumptions about learning and instruction differ from those of current instructional design models. Regardless of the particular model (c.f. Hartley & Sleeman, 1973; Hayes-Roth & Thorndyke, 1985; Park & Seidel, 1989; Wenger, 1987), all intelligent tutoring systems incorporate at least four major components: 1) the user interface; 2) the learner model; 3) the expert model, and; 4) pedagogic knowledge. As depicted in Figure 2, the learner and expert models are often combined into an area where diagnosis occurs through comparison between correct knowledge states (the expert model) and incorrect knowledge states (the learner model).

The *interface* is how the system communicates with the learner. This is a two-way communication where the learner is engaged in some activity while the system is interpreting the learner's activity so that a meaningful response can be made. The *expert model* is typically a database of correct knowledge states for a given domain. These states may be in the form of declarative or procedural knowledge organized in such a manner that the knowledge of an expert in the domain is accurately represented. Expert knowledge may be supplied to the system, generated dynamically, or both. The *learner model* is a representation of the errors or misconceptions that commonly occur when learners are exposed to the content, but can also include other information, such as a curriculum map of the learner's sequence through the curriculum. The system attempts to ascertain the knowledge that the learner possesses in order to be performing at the level and manner currently being exhibited. This diagnostic process is accomplished by comparing the learner's present knowledge state with knowledge in the expert model. The results of the comparison are then passed to the *pedagogical model*, where decisions are made about what, when, and how information is to be communicated to the learner.

Design Principles for Computer-Based Instruction

It is our contention that some aspects of each of the components in Figure 2 can be included in any type of computer-based instruction. The interface is important regardless of the type of software being developed, and in order to create instructional software, the content needs to be clearly defined and represented (the expert model). The learner is always considered, regardless of the delivery system, and instructional software must, by definition, contain knowledge about how to provide instruction (the pedagogical model). Therefore, the design and development of computer-based instruction and intelligent tutoring systems are not vastly different. The following discussion, while not intended to be an exhaustive review of the literature, presents general guidelines for designers of computer-based instruction derived from research in cognitive science and intelligent tutoring systems.

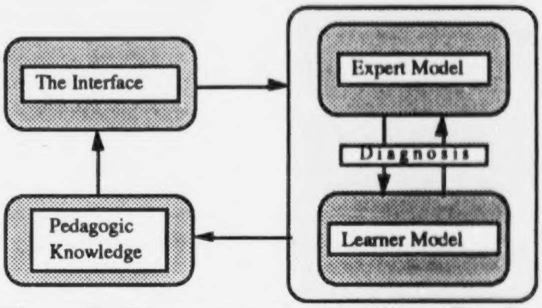

Figure 2. Components of an Intelligent Tutoring System.

The Interface. Much significant research has been completed in the area of human-computer interaction, and many principles based on cognitive theories have been proposed for user interface design (c.f. Card, Moran, & Newell, 1983; Norman & Draper, 1986; Shneiderman, 1987). The major problem is one of communication with the learner, since the communication is delayed. The designer must anticipate the possible actions a user may take, and devise ways to handle the actions before the user ever interacts with the software. This requires attention to aspects of learning, performance, subjective satisfaction, and retention of information as related to the interface, supported by iterative development, testing, and revision of the interface components (Shneiderman, 1987).

One of the primary considerations in designing a user interface should be ease of use. It is important to remember that the learner is not only learning the content, but is also learning how to operate the software. Screen design, use of special function keys, menu selection, and feedback on errors are just some of the aspects which need to be considered (c. f. Jay, 1983). The key in designing these components is consistency, so that the learners can make use of their knowledge about operating the software as they move from one screen to another, or from one program to another. Consistent interface design will also help to reduce the cognitive load on the learner (Norman & Draper, 1986; Shneiderman, 1987). For example, Anderson and his colleagues (Anderson, Boyle, & Reiser, 1985; Anderson & Reiser, 1985) have designed an interface to reduce the amount of information about the software that the learner must keep in memory, thereby minimizing interference between the learning task and operation of the software.

Interaction style is also an important part of interface design. An interaction style which is consistent with the learners knowledge of computers is most desirable. There are many possibilities, including command-driven, menu selection, and direct manipulation interfaces. Depending on the learner's expertise, one style might be more appropriate than another. For example, if the learner is a skilled computer user, a command-driven interaction style may be the most appropriate, but if the learner is relatively inexperienced, direct manipulation of objects with a mouse may be more desirable.

Metaphor can also be a powerful device for an effective interface, providing students with "comparisons which can help them learn" (Carroll & Mack, 1985; p. 40). Much of the applications software currently being marketed makes use of metaphor to help users be more productive. We have windows, trash cans, desktops, buttons, cards, folders, and pages. Such metaphors enable learners to build on their past experiences, and to map concepts in a well known domain to similar concepts and relations in a new domain. Complex metaphors may require sophisticated graphics capabilities and direct manipulation, but the benefits to the learners are worth the efforts. There are many metaphors in the classroom which are familiar to students, and which could be incorporated into an effective interface for learning.

The interface is not only a means for input and output of information, but can also supply important data about the learners. Depending on the domain, data from the interface can be used to monitor the learning process as it unfolds. If the content is process-oriented, the interface should be designed to monitor the learner's progress. For example, Orey and Burton (1990) designed an interface which supplied the system with more information about the child's subtraction process than just the answer to a problem. These data allowed the system to make decisions about the nature of the learner's subtraction errors. If the content is declarative, the interface should facilitate retention and organization. For example, the way in which an expert organizes knowledge in the field of her expertise might be depicted in some graphical form such as a content map, with the intention that the learner will develop a similar organization in obtaining domain proficiency.

The Expert Model, the Learner Model and Diagnosis. Experts in a domain organize knowledge and control problem-solving processes differently than novices (Glaser, 1989). The goal of instruction from a cognitive perspective, then, is to replicate the knowledge structures and processes of the expert in the mind of the learner (Wildman & Burton, 1981). In order to do so, the domain expert's knowledge must be mapped into symbols a computer can store and manipulate, and be presented to the learner in an organized manner. The appropriate form for knowledge representation is determined, in part, by the kinds of diagnostic procedures being implemented. Van Lehn (1988) describes the notion of bandwidth, which is the correspondence between observable actions of the learner and mental states within the learner. High bandwidth is the ideal case of a one-to-one correspondence between the learner's mental states and observable actions. Low bandwidth, on the other hand, would be the case when there are multiple mental states between observable actions performed by the learner. Where the system fits on the continuum between high bandwidth and low bandwidth is largely determined by the interface. For example, Orey and Burton (1990) used a process oriented interface to access as many actions as possible as the learner performed whole number subtraction. On the other hand, Brown and Burton (1978) used a system that only examined the completed answers to an entire subtraction test. There are a multitude of mental states that occurred before the system was able to diagnose errors. The result of the bandwidth diagnostic level for these two systems was that the diagnostic strategies and knowledge representation were entirely different.

The designer of computer-based instruction can make use of knowledge representation and diagnostic principles by focusing on high bandwidth diagnosis. First, an interface to support this level of diagnosis needs to be designed. Second, the most common types of errors that may occur need to be identified in order to construct a partial "model" of the learner that can be used for diagnosis. The type of error made by the learner can then be determined with extended conditional statements that are checked at the point of the error (context-specific error checking). In this way, a "mini" high bandwidth diagnostic system which uses an approximation of a production system can be implemented.

Simulation software is another area of computer-based instruction where the monitoring and diagnosis of user errors can be effectively applied. For example, suppose the simulation involves the operation of a nuclear power plant. The instantiation of a major error might result in the melt down of the simulated power plant, which may have dramatic effects on the learner's memory of the error. The error which caused the melt down, if properly communicated to the user, would hopefully not occur in the real world environment of running the power plant.

The Pedagogical Model. The pedagogical model contains knowledge necessary for making decisions about the teaching actions to be taken by the system. Since there tends to be considerable overlap between the functions of the various components of an intelligent tutoring system, the decisions and actions of the pedagogical model are highly dependent on the results of the diagnostic process. In general, the pedagogical model must decide when to present information to the learner, how to present the information, and what information to present. There have been a variety of pedagogical approaches employed in intelligent tutoring systems, but most of the current systems tend to implement only one pedagogical strategy. Intelligent tutoring systems, therefore, do not yet possess a rich repertoire of tutoring strategies from which to select, in part because so little is known about how to teach, especially in a one-to-one setting common in tutoring (Ohlsson, 1987).

In general, pedagogical strategies are dependent on the overall context of the learning environment embodied in the intelligent tutoring system. Three general types of environments have been implemented: systems which monitor student activity within a problem-solving domain, systems which employ mixed-initiative dialogue between learner and tutor, and systems which employ guided discovery or coaching (Wenger, 1987). The choice of tutoring environment is dictated by the nature of the content to be learned, the knowledge and experience of the learner, and the assumptions about learning inherent in the underlying theory on which the system is based. Current research with intelligent tutoring systems primarily focuses on context-based environments where students learn by working on specific, real-world problems, because cognitive theories have shown that knowledge and expertise is acquired by active application of knowledge during problem solving (Glaser, 1989). Further, learning strategies which make use of modeling of specific and appropriate procedures and strategies for problem-solving, and which strengthen existing knowledge through practice which minimizes error, have been successfully applied in intelligent tutoring systems research (Anderson, Boyle, & Reiser, 1985; White & Fredricksen, 1990). While these strategies are not significantly different from those already employed in some computer-based instruction, the use of context-based strategies which support situated cognition (Brown, Collins, & Duguid, 1989) is becoming an important factor in the development of intelligent tutoring systems which is not emphasized in current computer-based instruction, especially drill and practice and tutorial software.

Within a particular learning environment, a variety of teaching tactics can be implemented. Some of the possible tactics are presented in Table 1. Interested readers are referred to Wenger (1987) and Ohlsson (1987) for more detailed discussions of teaching tactics employed in intelligent tutoring systems. The selection and use of teaching tactics are governed by the characteristics of the learning environment, along with the general pedagogical approach. Various teaching tactics can be selected using an opportunistic approach (results of diagnosis reveal when opportunities for intervention are appropriate), or a plan-based approach (the focus of diagnosis is to monitor teaching plans and goals). Of course, a human tutor probably uses some combination of opportunistic and plan-based interventions, and research is currently focusing on the development of more sophisticated pedagogical techniques combining aspects of both pedagogical approaches (Wenger, 1987).

Table 1. Some teaching tactics employed in intelligent tutoring systems.

Presenting Information	Monitoring Performance	Error Detection
Socratic dialogue	Guided practice	Revealing errors on occurrence
Demonstration	Annotated practice	Marking for later explanation
Priming	Hints	Probability thresholds
Associative Links	Prompt self-review	Bug repair
Curriculum Maps	Prompt self-annotation	
Issues and Examples	Evaluate hypotheses	
Answer Questions	Coaching	
	Interactive simulation (Microworld)	

Many opportunities for integrating pedagogical strategies derived from research on intelligent tutoring systems are available for designers of computer-based instruction. For example, the work on conceptual models, as discussed by Mayer (1989), can provide an effective framework for applying cognitive theories of learning in computer-based instruction systems. As an illustration of this approach, consider the study conducted by Wertheimer (1959), which examined the differences between teaching children the formulae for the area of different geometrical shapes versus teaching children the conceptual explanation of those same formulae (see Figure 3). Initially the learner is given a paper parallelogram and a pair of scissors (Step 1 of Figure 3).

The child is then instructed to cut off the triangle on one side of the parallelogram (Step 2 and 3) and place it on the other side (Step 4). From this experience, the learner understands that the formula for the area of a parallelogram is A=B•H (Where A is the area, B is the base and H is the height, or in Figure 3, A=7•3=21). Direct manipulation or animation could be used to implement this strategy in computer-based instruction (Orey, 1985). The learner could be coached through the process, learning to "grab" the triangle with a mouse and place it on the other side of the parallelogram. Such an approach puts the learner in more control of the environment, and is consistent with the pedagogical strategies employed in intelligent tutoring systems.

Pedagogical knowledge, then, can be as important in computer-based instruction as it is in an intelligent tutoring system. There are many decisions to be made regarding not only strategies, but sequencing, and media (graphics, text, sound, or video). Certainly, more traditional approaches to computer-based instruction can be used as components of the pedagogical knowledge base (see Jonassen, 1988). Metacognitive considerations may also be incorporated within the pedagogical knowledge of a computer-based instructional system. That is, communication with the learner can be used to induce reflection on the learning process or to suggest alternative problem-solving strategies (Brown, 1975). In whatever manner, it is important for the designer to remember that learners are capable of controlling their own learning to some extent (Linn & Clancey, 1990; Winne, 1989).

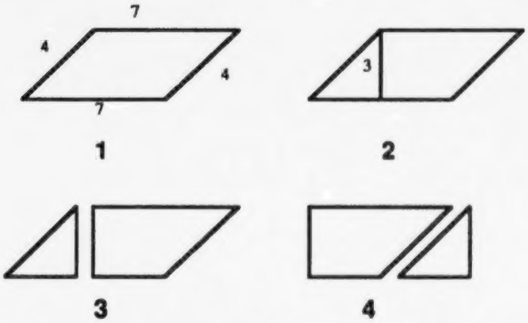

Figure 3. Wertheimer's (1959) conceptual model for teaching area.

Conclusions

We have sketched an approach to the design of computer-based instruction derived from cognitive psychology, in particular the design principles used in intelligent tutoring systems. As the analysis unfolded, we were struck by the idea that there were many similarities between intelligent tutoring systems and computer-based instruction that has been developed from a cognitive perspective. That is to say, rather than a dichotomy existing where the two poles are computer-based instruction and intelligent tutoring systems, actually there is a continuum anchored at one end by traditional computer-based instruction developed from an instructional systems design perspective (such as that found in many training settings), and at the other end by the "ideal" intelligent tutoring system. Some intelligent tutoring systems are not quite the ideal, and some computer-based instruction has been developed from a cognitive perspective. These systems overlap in the middle of the continuum. However, there is not a great amount of computer-based instruction developed from a cognitive perspective. As a discipline, we need to begin to shift toward the intelligent tutoring system. If we are to grow intellectually as a field of inquiry based in learning theory, then we need to be not only embracing the principles of cognitive psychology/science (which is a growing learning theory rather than a stagnate one), but applying it to instructional design and testing it in real learning settings.

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THEORETICAL FOUNDATIONS OF INSTRUCTIONAL APPLICATIONS OF COMPUTER-GENERATED ANIMATED VISUALS

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Abstract

Graphic tools abound in the development of computer-based instruction (CBI). This, coupled with the tendency to incorporate features particular to the computer medium has resulted in a proliferation of graphics in CBI. Animation is frequently incorporated into CBI, though designers and developers rarely have a firm rationale for its use. This paper discusses theoretical perspectives relevant to the application of animation in CBI. Perceptual theories are presented which help to explain how the illusion of motion is actually induced. Dual-coding theory is presented to explain how visual information is learned and remembered. This information is intended to familiarize designers and developers with the theoretical underpinnings which explain and support the use of animation in CBI. An understanding of this information should help guide decision-making of instructional applications of animation.

Introduction

Computer graphics, when designed appropriately, are believed to enhance learning from computer-based instruction (CBI) (Alesandrini, 1987). Several advantages of graphics are frequently noted. They can aid visualization of complex relationships between concepts and rules in short-term memory (Cooper & Shepherd, 1973). They can act as powerful mnemonics for remembering verbal information and concrete concepts (Paivio & Csapo, 1973; Pressley, 1976). Additionally, graphics are commonly believed to be effective attention-gaining devices and help increase the affective appeal of learning tasks and materials, though research on these issues is scant at best (eg. Surber & Leeder, 1988).

One graphic feature which has been excessively popular among CBI designers is animation. Computer animation can be defined as a series of rapidly changing computer screen displays that present the illusion of movement (Caraballo, 1985). Animation, whether on computer, film, or otherwise, is not *real* motion, but only its representation. Even the most sophisticated computer graphics systems operate on a "draw, erase, change position, draw" repetition to produce the illusion of motion. However, the theoretical and empirical foundations to explain and support the use of animation in instruction have not been firmly established.

Research on the use of instructional visuals, of which animation is a subset, has a long history. While visuals are constantly prone to distraction effects (Willows, 1978), conditions under which graphics can enhance learning have been described. The most notable of which is congruency between the learning task and instructional activities (Levie & Lentz, 1982; Levin, Anglin, & Carney, 1987; Levin & Lesgold, 1978). Instructional research on animation is much more recent, due, in part, to widespread availability of graphics tools in CBI authoring in recent years.

Animation research has focused on two fundamental applications of animation in CBI: 1) animation as a presentation strategy; and 2) practice activities involving interactive animated graphics (Rieber, 1990a). Recent reports have offered encouraging results for both applications (Reed, 1985; Rieber, 1990b, 1990; Rieber, Boyce, & Assad, 1990; White, 1984). Efficacy of animated presentations appears particularly dependent on task requirements, cognitive load, and attention-gaining devices.

The purpose of this paper is to describe several perceptual and psychological frameworks which support instructional applications of animation (see Rieber, 1990-a for a review of animation research conducted to date). First, perceptual factors are described which help to explain how the illusion of animation is made possible. This information should help guide designers to construct more convincing animated displays. Second, current views on how visuals contribute to long-term retention are discussed in the context of instructional design. These theoretical perspectives directly impact on why, when, and how to incorporate animated visuals effectively into CBI.

Perceptual Factors

Visual cognition is the process of how people perceive and remember visual information (Pinker, 1984). Perception is the process of selectively attending to and scanning a given stimulus, interpreting significant details or cues, and finally perceiving some general meaning (Levie, 1987). Students perceive meaning from animated visuals when they are tricked into seeing something that really is not there. Certain perceptual factors help to explain this phenomenon.

Animation is an example of *apparent motion* which is the phenomenon of perceiving motion when there is, in fact, no physical movement of an object in the visual field (Ramachandran & Anstis, 1986). (In contrast, *real* motion is experienced when an object actually moves across the receptive field of visual detecting neurons. The object crosses receptive fields of at least two neurons so that movement is perceived [Schouten, 1967].) Motion is perceived for two or more spatially separated and static objects which are alternately presented to the observer over time. Consequently, there is no actual motion of the image on the eye's retina. The visual system perceives motion by taking and combining discrete information into a smooth and continuous set. In other words, the mind, when confronted with a rapid series of still images, fills the gaps between the frames resulting in the perception of continuous motion. An everyday example is the popular use of neon lights to create a dynamic storefront display, such as moving arrows, to attract customers' attention to the shop.

The most intensively studied version of apparent motion is that perceived when two lights are presented at different times and different locations. This produces *stroboscopic* motion (also called Beta movement) (Kaufman, 1974; Schiffman, 1976). When images are shown at a rate of less than 16 frames per second, the motion appears choppy or jumpy. When individual, non-moving images are shown collectively at around 16 frames per second, the motion is *perceived* as smooth and continuous. Even the most inexpensive computer systems available today easily match this criterion.

Closely related to stroboscopic motion is the *phi phenomenon* (Schiffman, 1976). This is the illusion of motion produced when stationary lights are turned on and off in sequence. Examples of this phenomenon include theater marquee lights and scoreboards in sports arenas. The phi phenomenon also accounts for animation produced by the coordinated switching of pixels on computer displays. Both stroboscopic motion and the phi phenomenon are explained by several perceptual theories. (Other examples of apparent motion have been identified, such as the delta phenomenon, which is produced by varying the brightness of the stimuli [William, 1981].)

Of the many factors that determine the nature of apparent motion, three are particularly relevant in the design of animation on computer displays—ight intensity of the displays, time between projection of the separate displays, and the spatial distance between each of the displays. For example, two lights will be perceived separately (i.e. no perceived motion) when they are alternately presented at too slow a rate. Conversely, if they are alternated at too fast a rate, then the two points are perceived simultaneously, again, precluding the perception of motion. Beyond the individual importance of these factors, Korte's Law holds that apparent motion can only result when these factors are synchronized properly (Korte, 1915, as cited in Kaufman, 1974, and Carterette & Friedman, 1975). When one factor is held constant, the other two factors vary proportionally (though not necessarily directly). For example, if light intensity is held constant, the spatial distance between the displays for optimal apparent movement varies with the time interval between the displays. So, as the displays are moved further apart, the time between the projection of the displays must also increase. Other factors, such as spatial orientation, spatial frequency, depth plane, color, size, shape, and texture of the displays, also impact the perception of apparent motion, but the influence of each is considered quite small.

Psychological research has only now been able to describe the mechanisms by which the visual system (i.e. retina and brain) perceives apparent motion. In order to perceive an intermittently visible object as being in continuous motion the visual system must detect *correspondence* between the separate displays of a single object in motion (Mack, Klein, Hill, & Palumbo, 1989; Ramachandran & Anstis, 1986; Ullman, 1979). This is a top-down mental process in which the brain applies one organized and meaningful pattern to the separate images. For example, an animated scene of a person running across the computer screen may actually consist of 30 separate frames. The visual system "sees" all thirty frames but *perceives* only one object in motion. Detection of correspondence results in a type of cognitive "assembling" of the separate images into one meaningful set. Motion acts as the "glue" in this assembly process. If each successive display differs slightly from the previous one, correspondence detection is achieved and the visual system perceives motion in a *single* object. Explaining how the visual system solves the problem of correspondence detection is controversial. Several explanations have been offered. Over the years, perceptual psychologists have shifted away from the view that apparent motion is the result of a single psychological process to a two process theory. This latter view holds that there are two distincly qualitative processes at work: long-range and short-range apparent motion (Braddick, 1974, as cited in Petersik, 1989; Julesz, 1971). Research indicates that motion is perceived using either or both of these processes(There is competition between the two processes when each is equally stimulated. The conditions describing when one or both processes are elicited have not, as yet, been adequately determined [Pantle & Picciano, 1976].)

In the short-range process of perceiving motion, a display first stimulates the retina and the image is converted into an array of tiny points of varying brightness. This image is converted into an electrical signal which is carried along the optic nerve to the brain. The brain then compares each point with corresponding points in each succeeding display and discerns that *one* set of matched points composing a single object has changed its position by means of a yet-to-be-understood complex mental computation (Petersik, 1989). The brain then conducts a point-to-point matching by invalidating hundreds of potential matches and deeming them to be false.

The long-range process of perceiving motion provides a different explanation by contending that the visual system applies strategies that limit the number of matches that the brain needs to consider and thus avoids the need for a complex point-to-point comparison (Ramachandran & Anstis, 1986). This view suggests that the visual system uses a number of tricks evolved over the course of thousands of years. By taking advantage of the regularities of the physical work, the visual system extracts salient features from a complex display such as clusters of dots rather than individual dots and then searches for those features in the successive images. The features could be edges, short outlines, or areas of low spatial frequencies (blotches of brightness or darkness). Texture is another feature that appears salient to the visual system.

In the face of ambiguity, the visual system limits its perception of motion to those consistent with universal physical laws. It assumes that the physical world is not chaotic and random but organized and predictable. By capitalizing on these predictable physical properties, the visual system perceives linear motion in "preference" to one of abrupt change. The visual system also assumes that a moving object will progressively cover and uncover portions of a background. This means that if an opaque object temporarily covers the background, the unseen background is still perceived to exist (Ramachandran & Anstis, 1986).

In summary, apparent motion forms the basis of motion pictures (including films, videotapes, and laser discs), theater marquees, scoreboards and animation in computer software. In each case, the rate of picture presentation is crucial for the motion to perceived as smooth and continuous. Apparent motion occurs when a visual image persists for a brief period of time even though the physical stimulus ends. When photographs are shown at a proper rate, the image from each is taken and fused with proceeding and succeeding ones to form a perception of steady movement. Successive discrete images are integrated to produce an *apparently* continuous visual environment.

Long-term Memory Structures and Some Instructional Applications

Humans appear to be particularly adept visual learners (Kobayashi, 1986). The predominant theoretical explanation for this is dual-coding theory (Paivio, 1979, 1986). This theory suggests that there are independent encoding mechanisms, one visual and one verbal. Although competing hypotheses exist, such as those suggesting that all information (visual and verbal) is stored in propositional forms (Pylyshyn, 1981), dual-coding theory has considerable empirical support (Anderson, 1978).

Dual-coding theory contends that pictures and words activate independent visual and verbal codes and makes several assumptions. The first is that separate coding mechanisms are additive, so that something coded in both picture and verbal forms is more likely to be remembered (Kobayashi, 1986). The second assumption is that the availability of these two coding mechanisms differ in that a picture is more likely to be coded verbally and pictorially than words (Hannafin, 1983). Pictures are often remembered better than words because they are more likely to be encoded redundantly than words. The probability of recall is increased due to the availability of two mental representations instead of just one. If one memory trace is lost (whether visual or verbal), the other is still available.

Dual-coding is more likely to occur when the content is highly imageable (Paivio & Csapo, 1973). Concrete concepts, like "tree" or "chair", are good examples of information which readily produce internal images in most people. Conversely, people do not automatically form internal images for abstract concepts, like "justice" or "freedom". In these cases, it is often useful to provide the learner with a prototype image which communicates the most salient features of the concept. This prototypical image is frequently analogical to the concept, like a blindfolded person holding a set of scales to represent justice. Most of the supportive research shows that words, sentences, and paragraphs that are highly imageable are recalled better than those which are not and that the learning of concrete concepts precedes the learning of abstract concepts—concrete concepts are stored as images whereas abstract concepts are stored as verbal representations (Paivio, 1986).

Animation, like any picture, should aid recall when it illustrates highly imageable facts, concepts, or principles. Differences between animated graphics and static graphics is not as clear, but animated graphics are probably better at communicating ideas which involve changes over time because of its ability to represent motion, thereby reducing the level of abstraction of temporal ideas. For example, the motion of an animated car traveling from Boston to Washington accompanied by a display of the miles traveled and gallons of gasoline consumed helps to concretize the mathematical rule for computing average "miles per gallon". Static visuals represent, at best, visual "snapshots" of such ideas and are often accompanied by abstract symbols, such as arrows and dotted lines, in the hope of suggesting the motion attribute in static form. Learners must consciously work to connect and integrate these snapshots into a meaningful display, whereas animation triggers the automatic ability of the visual system to induce apparent motion, thus freeing short-term memory for other tasks.

Instruction often involves concepts and rules which not only change over time, but also in a certain direction. The direction of the path of travel of an object is defined as its *trajectory*. For example, many ideas in physical science, such as classical mechanics, not only require learners to understand that an object is moving at a certain speed, but also that it is moving in a certain direction. A case in point is velocity, which is defined as the speed and direction of a moving object.

If a learning task only requires learners to visualize information, then the use of static visuals would be sufficient. However, if the task demands that learners understand that an idea changes over time or involves directional characteristics, then static visuals, at best, can only hope to prompt learners to mentally construct motion and trajectory on their own (Often, merely prompting learners to internally image can be sufficient to produce learning effects. Studies involving static visuals have indicated that adults are much more likely to spontaneously form internal images than children, suggesting maturation effects [see Pressley, 1977].) However, animation makes this cognitive task more concrete by providing motion and trajectory attributes directly to the learner, thus allowing a more precise image to be perceived and potentially stored in long term memory.

Conclusion

Due to the wide scale and increasing availability of computers as an instructional delivery system and recent popularity of graphic tools, instructional applications of animation are destined to increase. In addition, the rapid increase in graphical user interfaces (GUI) on a wide range of computer platforms is unprecedented and this trend is also likely to increase. The purpose of this paper has been to provide instructional designers with background information related to the application of animation in CBI. Two main ideas have been presented. First, several perceptual theories were presented to describe how the illusion of animation is made possible on computer displays. Second, a dual-coding model was presented which provides general theoretical support for the storage and retrieval of pictorial information in long-term memory. Dual-coding is widely accepted as a suitable model for predicting picture facilitation effects (although it is not meant to represent a physiological model) (Anderson, 1978).

The fact that computers are capable of creating this illusion should come as no great surprise to most CBI developers as most commercial software packages already incorporate a myriad of examples of animation. However, an understanding of the underlying perceptual mechanisms should help in the design of more effective and convincing computer displays. It should also make us more appreciative of the human visual perception system. Motion perception is attributable to human capabilities much more than computer technology. An individual's schema, or organized network of world knowledge (Norman, 1982), has evolved to accept, expect and interpret motion. An individual "sees" motion in a collection of carefully coordinated static lights through top-down mental processing. This ability has evolved as a result of living in a dynamic world where very little information is truly static (Goldstein, Chance, Hoisington, & Buescher, 1982). Therefore, animation can help to represent the natural world in contrived settings, such as computer displays.

From an instructional point of view, this means that many ideas can be presented and understood in a natural and concrete way on the condition that motion and/or trajectory are important attributes to the ideas being conveyed. Rieber (1990a) has described four basic applications of animation in instruction: cosmetic, attention-gaining, presentation, and practice. Each application demands different development considerations. Of course, the fact that animation is incorporated into software in no way speaks to the effectiveness of the displays when the intent is to teach one or more intellectual skills. Instructional visual research has provided designers with one global principle: there are times when visuals can facilitate learning, times when visuals do not aid learning but do no harm, and times when visuals distract. Having the capability to produce animated displays does not automatically grant the designer the wisdom to use these techniques appropriately.

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THE INTERPLAY OF INTERACTIVITY AND MOTIVATION IN EDUCATIONAL SOFTWARE

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Abstract

Investigating the relationship between a program's interactive format and its motivational strengths, it was found that 5th grade students categorized educational software according to interactive genre. Results of a motivational ranking and clinical interviews indicate that each interactive genre requires an appropriate configuration of motivational elements to be appealing. It is recommended that designers capitalize on children's prior conceptions of interactivity to increase the appeal of educational software.

Introduction

This work explores the interplay between various types of software interactivity and the elements of a program that are intended to motivate the child. It is our hypothesis that children bring specifiable expectations to their interactions with educational software. These expectations, to a large extent, will determine which features of a given program will be motivating to a child. Additionally, the different genres of interactivity relied upon by software designers will elicit different expectations from a child and may resonate or conflict with the motivating elements built into the program. The state of affairs for the designer of educational software is much like that for the movie director. The director of a certain genre must include the elements the audience comes to see (e.g., the scary scenes of a horror movie) and not fully replace or confuse them with elements that work for other genres (e.g., slapstick). Similarly, the software designer must be attentive to the connections between the interactive elements upon which she relies and those elements that are appealing to a child.

The research reported in this paper represents an attempt to establish the validity of the above position prior to the development of verification oriented research. We think this is necessary as our conceptual approach is somewhat different from prior research in this area. Previous attempts to schematize or categorize software have often been done according to adult conceptualizations (e.g., Jonassen, 1985; Taylor, 1980). According to our hypothesis, it is the *child's* perception and categorization of programs, particularly the interactive aspects, that determine how we should think about designing software (c.f. Shapiro, 1987; Turkle, 1984; Winograd, 1986). Accordingly, our first research question is whether interactive formats have a strong enough influence on how children categorize software so that we may speak of *genres of interactivity*. A second way our research differs from previous approaches is that some of the best works on the motivational aspects of computer software have tended to ignore differences across software. For example, Malone (1981) writes of the role of challenge in creating motivation. Challenge, however, is not what motivates us to use a particular word processing program.[1] Rather we choose those programs that conform to our needs as writers. We intend to show that the motivating elements of software vary from program to program and are dependent to a large degree on the interactive premise of the software.

To begin exploring the relationship of interactive software and motivation we collected three sets of data:

- By having fifth graders sort software titles into piles of "like" programs, we investigated how children categorize educational software.
- We gathered information about the motivational power of programs by asking the students to indicate on a scale of one to three how much they like to use each program.
- Through group interviews we identify the interactive elements of the favored software genre - adventures.

All of the studies were conducted with fifth graders enrolled at Royale Elementary School in Darien, Connecticut. The Darien School District has an ample computer program that is laboratory based. Children use the computer lab during free time and regularly as part of class time. The software selection and usage is closely linked with the curriculum. There are enough computers for children to work individually if they choose. And, a full 75% of the children had computers (or video games) in their household. We comment where we feel this usage profile may impact the generality of our findings.

Genres of Interactivity

If children think of software in terms of interactive format, then it is reasonable to expect them to use similarities in interactive format across programs as a basis for categorization (cf. Chi, 1981). To decide if a cluster of programs coheres by interactive equivalences, without a crisp definition of interactivity, could be a dubious enterprise.[2] However, we expected that this problem of identification would not be too great. It was our prediction that students would create and label a few categories that unproblematically suggested interactivity.

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[1] In fairness, Malone (Malone & Lepper, 1984) later added an interpersonal dimension of motivational variables that capture the interactive appeal of a larger array of software.

[2] We take interactivity to mean something broader than, and prior to, a simple distinction between computer and "passive" media. As such, interactivity is a potentially unbounded concept ranging in examples from playing a game of tennis to reflecting on one's own thoughts. In attempting to define interactivity, one could easily flounder in debates over false problems: Can true interactivity only take place between two

Fourteen children (balanced for gender) each received a stack of 56 index cards that had an educational software title typed on one side. Children were directed to "sort the cards into piles of programs that are alike." No further instructions were given. Students were left to interpret "alike" and decide how many piles to create. The groupings were recorded and children were asked to label each pile.

A separate manipulation removed programs that a child had not actually used. We only consider the 26 programs that were known by at least half of the students in both the sorting task and the motivational ranking task below. The sortings were subjected to a cluster analysis using the Rao-Russel coefficient of similarity and a complete linkage approach. The label or labels that occur most frequently over all the programs within a cluster are used as names for the resulting cluster.

The analysis yielded seven clusters of programs that could be differentiated according to the labels assigned by the students. We give the label and our interpretation of the cluster along with the programs that were included. The order of the programs and clusters listed below replicates the ordinal positions within the final clustering. For example, *Bank Street Writer* is most closely linked to *LogoWriter* and most distant from *Path Tactics*.

Writing or Language Arts. These programs are typically seen as used for writing or typing practice. *Bank Street Writer, LogoWriter, Paws, Writer Rabbit.*

Print-out Programs. This category is defined by the program's emphasis on the goal of printing something out. Print *Shop, Print Shop Companion, Time Liner.*

Puzzles. One student called this type of program "mind puzzles." This category revolves around deductive style reasoning. *Gertrude's Puzzles, Puzzles & Posters.*

States or Social Studies. These programs all involve learning about the 50 states. However, the titles alone may define the category. *Dataquest: The Fifty States, Game of the States, States and Traits, Coast to Coast.*

Adventure/Journey/Mystery. The anchoring attribute of this category appears to be computer simulation of the physical world. One student made the astute distinction between mystery and adventure as one of solving vs. looking. These two types of programs are strong sub-clusters within this category. *Odell Lake, Oregon Trails, Goodell Diamond, Treasure Hunter.*

Putting things together. Students have to construct something and test it. *Clock Works, Woodcar Rally.*

Math. This category includes many of the programs that deal explicitly with number. Within this cluster there is a tendency for drill and practice programs to be associated with one and another. *Multiplication Puzzles, Subtraction Puzzles, Math Blaster, Circus Math, Quotient Quest, The Market Place, Path Tactics.*

There are two strong dimensions used to develop the categorizations: content area and interactive model. The three content area clusters, language arts, social studies, and mathematics, should not be very surprising. Given schools' strong partitioning of knowledge into curricular domains, one would expect children to bring their categorization of school experience to their categorization of software. This effect is probably heightened by Darien's use of the computer lab within class periods.

Of greater interest for our purposes are the other four groupings, especially the printer, adventure, and building programs. From this small sample of children and programs, it can be seen that children are quite attentive to interactivity in their conceptualization of software. Each of these represents an identifiable way of interacting in and with the world: using tools, navigating, searching, and creating. One might easily imagine that less interactive but more frequently touted aspects of software, such as graphics quality or engagingness, could have been used to equate the software. Interactive models are not limited to action in the physical world, although this is the currently favored genre of fifth graders. There also appears to be a sub-cluster within the math grouping in which the student competes with an animated agent within the computer, thus modeling interpersonal interactivity. Undoubtedly, there are many other models of interactivity upon which computer programs do or will rely.

Motivation and Types of Software

If programs are equally motivating but rely on different models of interactivity, it is likely that the motivation originates from different sources. To investigate the relationship of motivation to interactive formats, we operationalized the motivational strength of a program to mean how often a child likes to use the program. 22 fifth graders (balanced for gender) completed a questionnaire indicating how often (always, sometimes, never, unknown) they would choose to use each of the 56 programs in their free time. Below is the ranking,

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humans? Is drill and practice less or more interactive than inquiry-based software? Fortunately, our ultimate goal as researchers is not to come up with a necessary and sufficient definition of interactivity. Indeed, if there are concepts that are meaningful through the family resemblances of their examples, interactivity surely must be one. Rather, our goal is to organize discourse about those shared and differing attributes that characterize the many situations we call interactive.

from most motivating to least, of those programs that were known by at least half of the students. A score of three would represent the most motivating program.

(2.50) Oregon Trail
(2.50) Print Shop
(2.45) Odell Lake
(2.32) Bank Street Writer
(2.21) Print Shop Companion
(2.11) Wood Car Rally
(2.10) Goodell Diamond
(2.09) LogoWriter
(1.95) The Market Place
(1.94) Path Tactics
(1.94) Quotient Quest
(1.92) Dataquest: The Fifty States
(1.92) Puzzles and Posters
(1.83) Coast to Coast
(1.82) Multiplication Puzzles
(1.81) Time Liner
(1.80) Gertrude's Puzzles
(1.79) Game of the States
(1.72) Clock Works
(1.69) States and Traits
(1.68) Paws
(1.65) Circus Math
(1.58) Treasure Hunter
(1.55) Math Blaster
(1.46) Writer Rabbit

Attitudes towards software programs appear to be fairly well defined across the population as there is a highly significant effect for program type ($F = 6.9$). There is a significant effect on motivation when clusters are treated as groups within an ANOVA ($F = 7.75$). Adventures and the programs that generated printer output were significantly preferred to the other clusters (Scheffe test at $p < .05$) but not to one and another. We will discuss the source of this preference in the next section. Interestingly, there is an interaction between gender and program type ($F = 1.7, p < .03$) but not between gender and cluster type ($F = 1.45, p > .22$). This suggests that it is not math or writing per se to which girls and boys object, but rather specific, and perhaps prototypical, implementations of the category of software. However, the sample is too small to be confident in a failure to find effects or to begin parceling out interaction effects.

Oregon Trail and Print Shop are representative programs from the highly motivated clusters of adventure and print-out. These two programs are extremely different in the sorts of interactions, goals, and sources of satisfactions a student can expect. Although one might wish to claim that the same sorts of design elements make each motivating (e.g., an appropriate level of complexity or challenge), this seems to be the wrong level of analysis. We suggest that what makes each program so successful is the fit between the reasons the child wants to use the program and the interactive environment it creates. A program that includes navigational goals should create a spatial environment. Being able to jump from menu to menu in Oregon Trail (as is the case in Print Shop) would destroy the interactive premise of travel. It would undermine our expectations of interactions within a spatial environment. The program would lose much of the motivational power it gains by relying on our enjoyment and knowledge of navigating in the world.

The Source of Interactive Expectations

If children perceive a program as an adventure game, they prefer to see a first-person surrogate carry out their actions within the program's environment.[3] On the other hand, in a math, drill and practice setting, no such surrogate is expected (perhaps to move numbers around on the screen), nor does it seem to provide motivational enhancement beyond the temporary effects of novelty. Why might this be the case? In simplest fashion, much of what is enjoyable in software borrows from what is recognized as an enjoyable activity in the real world. Children have a prior model of interaction that includes surrogates (e.g., dolls) for fantasies. On the other hand, the activity and feedback involved with worksheets - animated or not - have never included the notion of a surrogate. There would be a mismatch between their expectations of the worksheet genre of interactivity and its delivery with fantasy elements.

Our central tenet is that children's motivation toward educational software can be understood to a large extent through the specifiable expectations children bring to the different genres of software. These genres of software are created and identified on the basis of the interactive models that rest upon the child's experiences in the world. We maintain this position because children bring previous real-world interactive experiences to their understanding of the various formats of educational software. It is easy to see how they analogize or equate software to various real-world activities (e.g., "This program is like going on a trip." "This one is like taking a test." "This one helps me make something.") They must import the goals of interactions in the world to find satisfaction within software. Software does not create goals and lasting motivation out of a vacuum - the computer is not *that* inherently motivating. Rather, a piece of software will borrow the motivating goal structure and the attendant interactive environment that supports a particular type of interaction in the world. The two most highly motivating clusters of programs, adventures and printing software are notable in their close linkage with the world. One facilitates interaction within a simulated physical world, the other assists social interaction through the creation of signs and cards. They each borrow their appeal through their different connections to real world interactions. Further, they each appear to be the most successful within their genre of software because they maintain fidelity to the previously experienced goals and environment of their interactive premise.

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[3] This was revealed through the group discussions considered in the next section.

What Might an Interactive Genre Look Like?

If children are given an opportunity to create a program, they will create one that is consistent with, and motivating because of, the interactive genre that serves as its premise. To explore whether students would emphasize a coherent set of interactive elements and what those might be, the two authors conducted group interviews with two different sets of five children. The question that anchored the discussion was, "If you were to make a computer program, what would it be like and what sorts of things would you include?"

The responses of both groups were strikingly similar in their preference for adventure games. Each group distinguished these from mysteries and puzzles. These results are in accordance with the distinctions uncovered by the clustering task and the motivational rankings. By looking at the different suggestions the students made, we get a better sense of the coherence of the interactive model and collect evidence for an extensive definition of the adventure genre of interactivity.

The children suggested that they wanted the manifestation of computer responses to be constrained by the same environment in which the student participates. We might call this a *causally coherent* model of interactivity in which consequences must reveal themselves through changes in the environment. All actions, student and computer, must be similarly constrained by the environment. Decisions that are made within the program should change the environment in a causal fashion. The legacy of these changes remains in play throughout the course of the interaction. For example, forgetting to plant the corn will become a damning mistake only when the food stores run out. Students pointed out several times that they did not want the program to give disengaged, omniscient, or external feedback; all consequences and computer reactions should be a natural result of the causal environment the program creates.

A second interactive model preferred for the adventure game is a spatio-temporal model. For example, they liked an ability to move in any direction spatially. This can be contrasted with programs in which the child always moves forward. However, complete freedom of movement and choice is not a superordinate principle of interactive design. The children explicitly stated that they did not like the capability of going back in time to correct a mistake. Ideally, an adventure environment will replicate the advantages and constraints of a spatio-temporal world.

Students repeatedly stated that they liked to explore and learn from their options and mistakes. They liked having to discover the sub-goals and emergent goals that must be satisfied to achieve the larger goal of the adventure. They wanted the program to be somewhat unpredictable but in a fashion consistent with the laws that govern the program's environment. They wanted optional levels of difficulty and novelty. In other words, they wanted to learn through interactions within a rich causal environment.

The adventure game relies on three basic interactive models that are derived from the child's interactions with the physical world: causality, spatio-temporality, and exploration.[4] The discovery or immersion learning style they have chosen finds a natural model within their own lives (Papert, 1980). However, it is important to note that this is only one genre of interactivity and a style of learning that grows from it. It is important to imagine what sorts of social interactivity and learning styles will become supportable as computer power becomes more available in the classroom.

Directions and Conclusion

The methods of enhancing motivation within different interactive settings will differ depending on the goals the user generally attributes to certain types of interaction. Although the goal is ultimately to learn something, the use of interactivity can bring a much larger set of goals and expectations to bear. It is central to any interactive design that these expectations are played upon. As a first step in delineating the nature of these expectations, it is worthwhile to think of the different types of interactions a user might expect within a given genre of interactivity. A practical way for a designer to follow this prescription is to ask herself what sort of interaction does this computer instruction seem most like and what sort of role does the computer play in the interaction (e.g., partner, adversary, game board, world, referee, reference tool, museum, etc.). Subsequently, the designer can consider what things make this sort of interaction most satisfying and work onward.

The unique features of the new and highly plastic interactive technologies have not been fully explored, either theoretically or empirically. Designers currently rely on models of development that are often out-dated or prematurely reductionistic. Much of the literature on motivation in instructional technology attempts to include all designs within large matrices and continuums of factors. They do not take into account the qualitative differences of children's expectations in their encounters with instructional technologies. Much like film, there are genres of software (in use and developing) that capitalize on the child's motivations in fundamentally different ways. Our future research will attempt to prove the interrelation of interactive format and motivation through an experimental design. However, the next step is to continue the discourse with children about the different interactive elements and their groupings into genres. It is here that we will find the best ingredients for coherent and motivating design recipes.

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[4] There were other elements of adventure games that the children mentioned such as codes, fantasy, and being able to choose the characteristics of their surrogates. There were also things that children claimed were unimportant: Graphics, high action, points, winning, and, sound. It is worth noting that some of the things excluded are precisely those features that are mandatory for the success of other genres of interactivity. It would be informative to ask students to design the ideal drill and practice program as a source of contrast.

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TECHNIQUES AND PROCEDURES FOR THE TRANSPARENT AUTOMATIC COLLECTION OF DATA FOR HYPERMEDIA-BASED RESEARCH

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Abstract

An integrated hypermedia training curriculum, utilizing computers and interactive videodiscs, is being developed at Lehigh University for staff and personnel of the Cities in Schools, Inc., a national program addressing the critical problem of coordinating the delivery of human services to at-risk youth and their families. Cities in Schools programs address the problems of dropout prevention, drug abuse prevention, teen pregnancy, and teen violence. Extensive information is needed on how trainees utilize the integrated hypermedia materials, how they feel about using them, and what they learned. The formative evaluation component of the project seeks to provide this information efficiently and unobtrusively by using techniques and procedures to provide transparent automatic collection of data relating to use of the curriculum materials. This paper will describe techniques and procedures in use and under development to provide curriculum designers and developers comprehensive information on how trainees use the training curriculum, how they feel about the training, and what they learned from it. The extension of these techniques for utilization in a formal research program on hypermedia will also be discussed.

The Cities In Schools Program

Cities in Schools is a national non-profit corporation with headquarters in Washington, DC, and regional offices in Pittsburgh, Atlanta, Chicago, Los Angeles, and Austin, Texas. Recognized as a national leader in promoting and facilitating the coordinated delivery of existing health, social, education, and other support services for at-risk youth and their families, Cities in Schools seeks to develop private/public partnerships designed to connect appropriate human services with at-risk youth in addressing such critical issues as school attendance, literacy, job preparedness, teen pregnancy, drug and alcohol abuse, teen suicide, and school violence. Cities in Schools is in the process of establishing and providing training and technical assistance to a national network of centers to coordinate the delivery of multiple, existing social services to at-risk students and their families.

Current and Future C.I.S. Hypermedia Project Activities

The Cities in Schools Curriculum Project began in February, 1989, and completed Phase One of the project (the development, testing, and related staff training for training modules on history, organization, and the Cities in Schools replication process) in August, 1989. The experiences gained in developing the Phase One Cities in Schools hypermedia materials and preliminary results of their use in actual training have demonstrated the value of the approach taken. Two additional factors have influenced the future direction of the project. First, it was felt both by Cities in Schools staff and the hypermedia development team that two of the primary objectives of Cities in Schools training were to convey the philosophy of Cities in Schools and to develop an emotional as well as intellectual commitment to its goals. This philosophy embodies a commitment to decentralization and local community control. Cities in Schools is described by William Milliken, its president and one of its founders, as "a mission in the process of becoming a program" (Milliken, 1989). It was felt that motion video was necessary in order to convey the philosophy effectively and to promote the desired commitment. The second influencing factor is that Cities in Schools has, since its inception, made extensive use of videotape in documenting its programs and in disseminating information about them. Thus, a considerable amount of videotape materials about the program already existed.

For these and other reasons, it was decided that the next phase of the Cities in Schools hypermedia project would involve the redesign of the entire training curriculum as an integrated hypermedia-based curriculum. This curriculum will utilize the full range of multimedia materials, including motion video, as well as print materials.

This phase of the project calls for a year-long project beginning in August, 1989. A complete review of the Phase One curriculum materials will be conducted, and an overall plan for the goals, scope, instructional approach, and general philosophy of the integrated hypermedia curriculum will be developed, along with a list of available print, photographic, and video resources which might be included. During the spring of 1990, additional video materials will be produced. These will be combined with existing video materials and transferred to interactive videodisc. At the same time the hypermedia software will be rewritten to integrate the videodisc materials into the overall curriculum. The complete curriculum will be completed and tested during the summer of 1990 at the proposed Cities in Schools National Center for Partnership Development jointly sponsored by Cities in Schools, Inc., the College of Education at Lehigh University, and Lehigh's Iacocca Institute.

The Need for Formative Research

As Jonassen has stated, hypermedia is a rapidly expanding technology that offers considerable instructional potential (Jonassen, 1988). However, significant problems with hypermedia challenge both authors and users. Kearsley points out a number of formatting and organizations issues (Kearsley, 1988). There is a need for complete information on how the user uses the hypermedia materials, how the user responds to the hypermedia materials, and what is learned from the hypermedia materials. This information is important to the designers and developers for use in improving existing hypermedia materials and in designing future materials. These formative research activities can also provide the foundation for future more systematic and more formal research on using and learning from hypermedia.

An efficient method to collect needed information will utilize the hypermedia technology itself, incorporating data collection into the actual hypermedia training modules. Data collection methods used should be transparent to the user to minimize distracting the user or interfering with learning from the hypermedia materials. To meet the needs of the Cities in Schools Hypermedia Development Project for formative evaluation data, a series of such procedures have been developed or are under development by project staff. The following section will present the types of information to be collected, explain why that information is needed, and briefly describe the techniques used to collect that information. These techniques were developed through custom programming in HyperCard for Macintosh computers. Advanced textbooks on HyperTalk programming [for example, Goodman, D. (1988), Goodman, P. (1989), Michel, (1989), Shafer (1988), the Waite Group (1989)] were used as guides for developing these techniques.

Transparent Automatic Data Collection Techniques

Type and Sections of Training Curriculum Used. Users will be exposed to a variety of curriculum modules or to different versions of the same module. The hypermedia training materials automatically record the particular modules or version used for later cross-reference to user achievement, user attitudes, and other variables.

User ID or code. It is essential to keep track of users in the evaluation procedures. To facilitate this, a unique identification number is automatically assigned to each user the first time he or she uses the hypermedia. If needed, at this point the user is also asked to enter additional demographic data such as age, sex, highest grade completed, etc. This information is automatically stored with other data for each user, and can then be used to identify aggregate information about test groups. The procedure guarantees anonymity for the user while providing efficient tracking of individual activity. For some applications, users have been given preassigned identification numbers. In these cases, the hypermedia system will prompt for this information, and will not proceed the user enters the correct information. Pressing the [Return] key will have no effect until the task is completed.

Data Related to Time on Task. For each session, data on the time begun and time ended and the date are needed. This information will be useful for recording time on task and for tracking testing or training schedules. The date and time are recorded immediately after recording the user ID. The time the user quits the session is recorded before termination of the session when user presses a [Quit] function.

Score on Achievement of Learning Objectives. It is necessary to keep the raw score of the users as they complete the built-in tests for achievement of training objectives. This information is needed to perform various analyses to determine how much learning has taken place. When the user presses the [SCORE] function the score of the test is recorded to the screen and to a hidden text field. When the user leaves the [TEST] screen the score is recorded to a hidden text field and saved for later analysis.

Item Analysis of Built-In Achievement Tests. Validation of built-In achievement tests requires recording which questions were responded to correctly or incorrectly. When the user presses the [SCORE] function or leaves the [TEST] screen the procedure records which questions were answered incorrectly or not answered. The procedure will also record which response was chosen for each question for later use in item analysis.

Sequence of Using Material. From the perspective of learning theory, hypermedia should improve learning because it focuses attention on relationships between ideas rather than on isolated facts (Kearsley, G., 1988). To investigate this perspective it is necessary to identify and to record the sequence in which a user progresses through hypermedia materials. When the user accesses a screen, a hidden text field on that screen is marked to indicate the screen has been accessed. The ID number, card number, or card title is also recorded in a text field on a separate card, generating a list of materials used in the order in which they were accessed. This process continues until the user presses the [QUIT] function.

Amount of Hypermedia Material Used. Hypermedia materials contain a vast amount of information. This information may be in the form of text, graphics, still photographs, or video. It is necessary to establish how much of the total amount of information available was used by the user. This information can be used to determine whether there was not enough material available to the user or conversely whether too much material was available, thus overwhelming the user.

The amount of hypermedia material used is recorded in a hidden text field on a separate tracking card. The ID number or title of a screen is recorded each time that screen is accessed, and the screen itself is marked as having been accessed. When user presses the [Quit] function, a list of screens which were not accessed, the total number of screens not accessed, and the percentage of the total amount of hypermedia accessed is recorded automatically.

Amount and Effectiveness of Use of Navigational Aids. As Jonassen has stated, one of the most obvious user problems is navigation through hypermedia (Jonassen, D., 1988). How does a user use navigational aids to navigate through hypermedia material? This technique will enable a developer to "see" how the user utilizes navigational aids. Every time a specific navigational aid is used this fact is recorded. The tracking procedure can be set to record each time the navigational aid is used or the total number of times it is used. The procedure also records from which screen the navigational aid was activated and/or to which screen the user linked. When user presses the [Quit] function the hidden text field is then checked and the information recorded.

Degree of Exposure to Information Related to Specific Objectives. It is important that a user be exposed to all of the relevant hypermedia material for a given objective. It is also important for developers to know how much of a given amount of information the user has been exposed to. This may be used to interpret a user's score or to determine the minimum amount of exposure to material for a given objective needed to meet training objectives. To record this information each screen of information is tagged with a hidden text field that identifies the related objective. When the screen is accessed a text field on a separate record card records the screen ID and related objective. When user presses the [Quit] function the tracking information is compiled and recorded. The screens that have not been tagged as having been accessed are also recorded along with their related objective number or ID.

Provide for Open-Ended User Feedback. While developers have tried to foresee and address many of the problems that users may encounter, there is still the need for constructive user feedback. The user has the option to enter a NOTE/QUESTION screen at any point in the hypermedia. This enables the user to record any questions or concerns he or she might have concerning this particular training module. These questions will then be recorded at the end of the session.

Generating Summary Reports. It is of no benefit to acquire large amounts of information and not use it. The purpose of the techniques described in this paper is to gather useful information using mechanisms transparent to the user and then present that information to trainers and curriculum developers in a useable form. The information gathered by these procedures and techniques can be recorded as a separate document for each factor measured or recorded as one large document.

Relationship to Formal Research. The procedures and techniques described in this paper have been developed to guide and to support the development of effective hypermedia training materials. Emphasis has been placed on gathering useful information quickly and unobtrusively. The techniques developed, however, are also potentially useful for more formal research investigations. The experience in developing and implementing the formative evaluation component of the Cities in Schools Hypermedia Development Project will provide a firm foundation for later formal research investigations. Project staff are now developing a research agenda for systematic investigation of how specific hypermedia factors relate to learning and user attitude.

Conclusion

Hypermedia technology is a new and exciting medium. As with all technology, effective use of hypermedia depends on careful and systematic investigation of how the technology is used and of the effect of changes in specific attributes of the technology on learning, user attitudes, and ease of use. Formative evaluation activities attempt to carry out these systematic investigations in the context of an ongoing technology development project, while more formal research projects attempt to answer similar questions in a more systematic and longer term way. Hypermedia is unique in the amount of data collection techniques that can be incorporated into the hypermedia materials being evaluated. It is hoped that the techniques described in this paper will promote the more efficient and more comprehensive collection of data on hypermedia. These and continuations of these activities, we believe, will contribute to greater understanding and more effective use of hypermedia technology.

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MANAGEMENT DEVELOPMENT TRAINING AND LEARNING STYLES: AN EVALUATION OF THE APPLICABILITY OF MULTIMEDIA INSTRUCTION

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Abstract

The development of an approach for the training of Georgia Department of Corrections managers has evolved from the findings of an objective empirical study. The commission of this study, *Management Development Training Evaluation for the Georgia Department of Corrections*, produced some new correctional training issues not previously studied. Based on the results of one empirically-based component of the study, the project team discovered differences in the learning styles of the sample large enough to dictate the use of different instructional approaches with particular groups of trainees. Results of this study also contributed to the development of a learning environment model that will allow correctional trainers to design and implement instructional activities for particular groups of trainees. Furthermore, the findings of this study will enable the Department to develop new strategies to proceed toward a training program that will best meet the needs of the training population.

Currently, the Georgia Department of Corrections is experiencing unprecedented growth in the numbers of staff, facilities, and offenders under supervision. Of critical interest to the Department is the need to train and develop staff at all levels of management in the most effective and efficient manner. Consequently, one question this study attempted to address was whether the instructional strategy in place at the time this study was commissioned was the most effective and efficient in accomplishing the Department's goal of having a trained and qualified pool of managers. Therefore, the primary purpose of this study was to examine the appropriateness and applicability of using a multimedia instructional strategy in implementing the Management Development Training Program within the Georgia Department of Corrections.

One component of this study was designed to reveal whether or not there were any statistically significant differences in the learning styles of the target training population (that is, between the supervisors, middle managers, and upper managers within the Facilities Division and Probation Division). Another objective was to identify which training media and instructional methodologies were most suited to the dominant learning styles of the training population. Consequently, results of this study will serve as a guide in evaluating, recommending and designing learning experiences and techniques of multimedia delivery that best match students' styles with the learning objectives of individual training programs.

Method

Subjects. The target population in this study consisted of individuals employed by the Georgia Department of Corrections in supervisory and managerial positions. Subjects in this population represent the full range of managerial job classifications as identified by the Staff Training and Development Section.

The population of managers consisted of 890 individuals (69 job classifications) grouped as supervisory management, middle management, upper-middle management, upper management and executive management. Although the top managers within Central Office executive management were not one of the focal management types to be examined, surveys were reviewed and approved by them for distribution to their subordinates. In fact, several were completed by these managers and returned to the project team.A stratified proportionate random sample of the population was used. The population was divided into five strata using criteria developed by the Staff Training and Development Section of the Georgia Department of Corrections. The underlying rationale was to divide the population into groups based on the guidelines used to determine the composition of the training classes themselves.

In order to determine the size of the sample required to estimate the population proportion, a pilot study was conducted. Application of the general formula for estimating population totals (Jaeger, 1984) indicated that an overall sample size of 302 was required in order to estimate population means within a .75 error limit and 95% confidence level.

In order to ensure an adequate response rate (return rate for the pilot study was 75%), 402 supervisory and managerial personnel were randomly selected with a roughly proportionate number of subjects from each stratum (the two smallest strata were oversampled). The sample included 133 supervisors, 128 middle managers, 35 upper-middle managers, 91 upper managers, and 15 executive managers. This sample represents 45% of the population of supervisory and managerial personnel in the Georgia Department of Corrections.

Instrumentation. One questionnaire in the survey packet was Kolb's LSI, a widely used learning style inventory that allows learners to be classified by their dominant or preferred learning style and corresponding learning environment derived from experiential learning theory. Responses to the LSI were used to determine whether there were any differences in the learning styles of the training population. The LSI is designed to be self- administering with simple instructions and an example. The four basic scales all have very good internal reliability as measured by Cronbach's alpha (.82, .73, .83, .78) (Kolb, 1984). Despite the weaknesses suggested by some research concerning certain properties of the LSI, work by other researchers, such as Karrer (1988), state that learning style instruments other than the Kolb are even more suspect.

Experiential learning is conceived as a four-stage learning cycle. At any stage of a learning cycle, different abilities are required of the learner: concrete experience (CE) abilities, reflective observation (RO) abilities, abstract conceptualization (AC) abilities and active experimentation (AE) abilities. Learners input information either from experience (CE) or from abstractions (AC) and process information either from internally reflecting on the experience (RO) or externally acting upon the conclusions which have been drawn (AE).

Presentation of the Data and Results The distribution of the survey packet and the reminder postcard sent two weeks later brought an 87% return of completed questionnaires. A total of 333 acceptable surveys (83% returned and found usable) were used in the data analysis.

Data Analysis of LSI. The computer scoring procedure of the Kolb Inventory was in accordance with the scoring procedure from the LSI Manual (Kolb, 1986). Reliability estimates using Cronbach's coefficient alpha yielded the following strong reliability coefficients: .75 for Concrete Experience, .79 for Reflective Observation, .81 for Abstract Conceptualization, and .84 for Active Experimentation. Since these reliability estimates were as high if not higher than those reported previously in the research literature, the project team determined that the LSI data collected in this study was highly suitable for the research application described herein.

In accordance with the scoring procedure from the Learning Style Inventory Technical Manual, scores on the four scales of the LSI (CE, RO, AC, AE) were combined to equal the two learning dimensions which identified the dominant learning style for the training population. The two major learning dimensions were Abstract-Concrete (AC-CE) and Active-Reflective (AE-RO).

One important area examined in this study focused on whether or not there were any learning style differences between field personnel who work in the Facilities Division (prisons) and those who work in the Probation Division (programs). The Department wanted to determine whether integrating staff from these operational divisions into the same training programs would enhance or detract from the learning experience in the classroom. The "Facilities Division" includes supervisors and managers who are employed in the typical "prison institution" and the "Probation Division" includes supervisors and managers who work with a probation type of "program." Field supervisory and managerial personnel who work in these divisions make up the majority of the training population (as well as the sample). Table 1 presents the means and standard deviations on the four scales of the LSI by division type of field personnel.

Table 1 indicates that some differences may exist in the abilities of Facilities and Probation Division personnel to perceive information. Facilities Division personnel scored higher than Probation Division personnel on taking in information concretely (CE mean = 26.06 and 24.65, respectively). Furthermore, Probation Division personnel scored higher than Facilities Division personnel in perceiving information abstractly (AC mean = 32.03 and 30.26, respectively). Table 1 also indicates smaller differences in how Facilities Division and Probation Division field personnel processed information (AE mean = 31.86 and 30.62, RO mean = 32.70 and 31.84, respectively).

Multivariate analyses of variance (MANOVA) were used to assess differences in mean scores along the two learning style dimensions. These different analyses examined differences between division types (Facilities and Probation). In addition, differences in management types within both divisions were also investigated.

Table 1. Means and Standard Deviations of Learning Style Abilities by Division Type of Field Personnel

Division Type of Filed Personnel	Learning Style Scale Scores								
		CE		RO		AC		AE	
	n	M	SD	M	SD	M	SD	M	SD
Facilities	194	26.06	6.40	31.84	6.91	30.26	5.92	31.86	7.16
Probation	60	24.65	6.62	32.70	6.61	32.03	6.88	30.62	7.26

Due to the exploratory and non-experimental nature of this study, a .10 level of significance was used throughout these analyses of variance. The univariate F values indicate results which would have been produced if each dependent variable had been analyzed in isolation.

The goal in the first MANOVA was to determine whether scores on the two separate learning dimensions were different for the Facilities Division field personnel and Probation Division field personnel. Results are presented in Table 2.

Table 2. Multivariate Analysis of Variance (MANOVA) Comparing Learning Style Dimensions by Division Type of Field Personnel

Dependent Variable	MS	Error MS	F Value
ACCE	464.09	108.28	4.29**
AERO	202.86	145.89	1.39
Multivariate Test of Significance (Pillais)			1.37*

**p* < .10.; ***p* < .05.

Note. Multivariate normality and homogeneity of variance-covariance; matrices assumptions were tested and robustness ensured. Adjustments for unequal sample sizes among the different management types were also considered in the analysis

Results of the MANOVA procedure indicated that learning style preference as measured by the LSI differed significantly among the sample of Facilities Division and Probation Division supervisors and managers ($F = 1.37$, $p = .08$). The univariate F tests revealed significant differences in the AC-CE learning dimension ($F = 4.29$, $p = .04$) but not the AE-RO learning dimension ($F = 1.39$, $p = .24$).

Of further training-related interest was the examination of differences in the management types within both the Facilities Division and Probation Division managerial personnel. Due to the difference between the management structures of the divisions (the Facilities Division has a more extensive middle management structure), two separate analyses were necessary. The first analysis pertained to field supervisors and managers within the Facilities Division. The following table presents the means and the standard deviations on the four LSI scales of Facilities Division field personnel by management type.

Table 3. Means and Standard Deviations of Learning Style Abilities of Facilities Division Field Personnel by Management Type

Management Type	Learning Style Scale Scores								
		CE		RO		AC		AE	
	n	M	SD	M	SD	M	SD	M	SD
Upper	22	27.86	6.74	28.73	5.40	27.77	6.17	35.73	5.39
Upper Mid	26	25.31	6.72	32.65	6.16	32.81	6.18	29.23	6.50
Middle	77	25.91	6.92	32.03	7.85	30.52	5.96	31.56	8.29
Supervisor	69	25.94	5.55	32.30	6.33	29.81	5.42	31.94	6.03

Table 3 indicates that some differences exist in the abilities of Facilities Division supervisors and managers to receive, as well as process, information. The largest differences appear to be between upper managers and the other management types. For example, upper managers score higher than the other management types on perceiving information concretely (CE mean = 27.86), and lower than the other management types when perceiving information abstractly (AC mean = 27.77). Upper management Facility Division field personnel also score higher than the other management types in processing information actively (AE mean = 35.73), and lower than the other management types in processing information reflectively (RO mean = 28.73). A MANOVA was then used to discover whether scores on the two separate learning dimensions were significantly different for the Facilities Division management types. The results of the MANOVA procedure are presented in Table 4.

Table 4. *Multivariate* Analysis of Variance (MANOVA) Comparing Learning A Style Dimensions of Facilities Division Personnel by Management Type

Dependent Variable	MS	Error MS	F Value
ACCE	236.23	98.40	2.40*
AERO	469.49	141.43	3.32**
Multivariate Test of Significance (Pillais)			2.40**

*$p < .10$.; **$p < .05$.

Note. *Multivariate normality and homogeneity of variance-covariance matrices assumptions were tested. Robustness was ensured with the AC-CE dimension but not the AE-RO dimension. Results pertaining to the AERO dimension should be interpreted with caution. Adjustments for unequal sample sizes among the different management types were also considered in the analysis.*

Results of the MANOVA procedure indicate that learning style preference, as measured by the LSI, differed significantly among the Facilities Division management types ($F = 2.40, p = .027$). In this case, the univariate F tests revealed significant differences in the AC-CE learning dimension ($F = 2.40, p = .069$) and the AE-RO learning dimension ($F = 3.32, p = .021$).

Since the learning style dimensions of the four management types were found to be significantly different, a multiple comparison test was used to determine what significant pairwise differences existed. Due to the exploratory nature of this study, a liberal multiple comparison test (Fisher's LSD) was used to determine which management types were significantly different at the .05 level of significance. Table 5 summarizes the results of the multiple comparison test by indicating where a statistically significant difference occurred.

Table 5. Summary of Results of Multiple Comparison Tests on Learning Style Dimensions

Learning Dimension	Facilities Division Management Type			
	Upper	Supervisor	Middle	Upper Mid
AC-CE	n = 22	n = 69	n = 77	n = 26
Mean	-.09	3.87	4.61	7.5
	Middle	Supervisor	Upper Mid	Upper
AE-RO	n = 77	n = 69	n = 26	n = 22
Mean	-.49	-.36	-3.42	7.0

Note. *Any management types underlined by a common line did not differ significantly. Management types are rank-ordered with respect to mean scores arranged in order of magnitude from the smallest to the largest.*

Table 5 indicates that, with respect to the AC-CE learning dimension, there were significant differences in the learning styles of upper management and upper middle management, as well as between upper management and middle management Facilities Division personnel. With respect to the AE-RO learning dimension, significant differences were noted between upper and upper middle management, upper and middle management, and upper and supervisory management Facilities Division personnel.

The following analyses pertain to Probation Division field personnel. Table 6 presents the means and the standard deviations of the four LSI scales for Probation Division field personnel separated by management type.

Table 6 indicates that small differences existed in the learning abilities of Probation Division upper management and supervisory management field personnel. The most apparent difference appeared to be between upper managers and supervisors in perceiving information concretely. Probation Division upper managers scored higher than supervisors in perceiving information concretely (CE mean = 25.95 and 22.41, respectively), and lower than supervisors in perceiving information abstractly (AC mean = 31.37 and 33.18, respectively). Upper management Probation Division personnel also scored higher than Probation Division supervisors in processing information actively (AE mean = 30.71 and 30.45, respectively) and lower than supervisors in processing information reflectively (RO mean = 31.97 and 33.96, respectively). It is interesting to note that these same differences, though not as large, were discernible with respect to the learning abilities of upper management Facilities Division personnel and their subordinates.

Table 6. Means and Standard Deviations of Learning Style Abilities of Probation Division Field Personnel by Management Type

Management Type	Learning Style Scale Scores								
		CE		RO		AC		AE	
	n	M	SD	M	SD	M	SD	M	SD
Upper	38	25.95	6.41	31.97	6.64	31.37	6.80	30.71	7.30
Supervisor	22	22.41	6.52	33.96	6.52	33.18	7.04	30.45	7.35

A MANOVA was used to determine whether scores on the two learning dimensions were significantly different for the upper and supervisor Probation Division management types. The results of this MANOVA procedure are presented in Table 7.

Table 7. Multivariate Analysis of Variance (MANOVA) Comparing Learning Style Dimensions of Probation Division Field Personnel by Management Type

Dependent Variable	MS	Error MS	F Value
ACCE	399.06	129.02	3.09*
AERO	69.71	145.08	.48
Multivariate Test of Significance (Pillais)			1.77

*$p < .10$

Note . Multivariate normality and homogeneity of variance-covariance matrices assumptions were tested and robustness was ensured with both the AC-CE and the AE-RO learning dimensions. Adjustments for unequal sample sizes among the two different management types were also considered in the analysis.

Results of the MANOVA procedure indicated that learning style preference as measured by the LSI did not differ significantly among the sample of Probation Division upper management and supervisory management personnel ($F = 1.77, p = .179$). However, one univariate F test indicated a significant difference in the AC-CE learning dimension scores ($F = 3.09, p = .084$), while the other indicated no significant difference with respect to the AE-RO learning dimension ($F = .48, p = .49$).

Recommendations

The data obtained from the LSI can be used in many ways in training related matters. Perhaps the most obvious is for the purpose of designing instruction prior to the implementation of training for each particular group of trainees. Using the results summarized in this report, methodologies and media approaches can be planned to meet the needs of the majority of training participants.

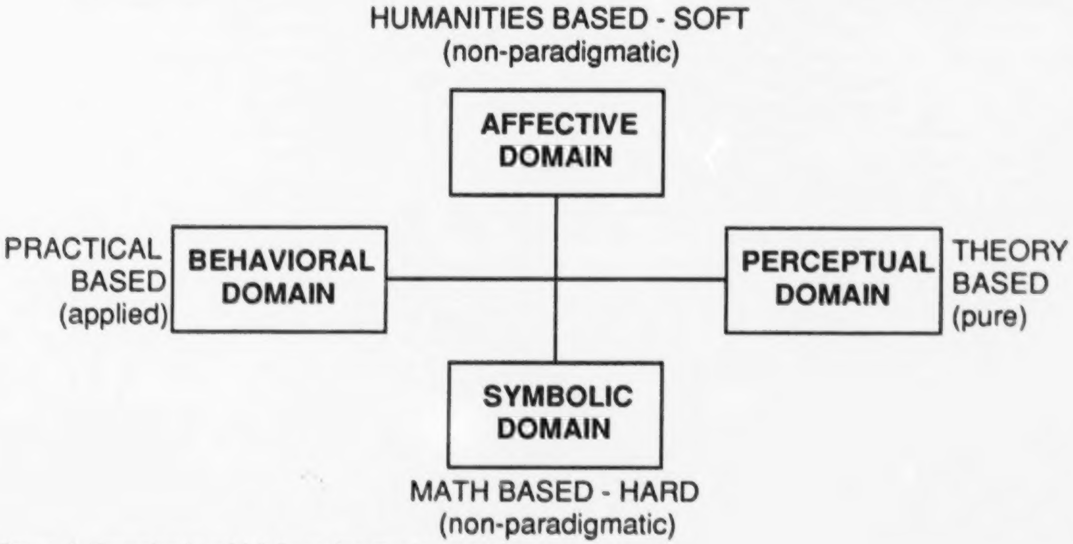

Figure 1. Domains in which Learning Environments vary.

Matches between learning styles and measures of environmental complexity could lead to higher learning outcomes and more learner satisfaction. (Fry, 1978). Research by Biglan (1973) and Kolb (1975) has produced a model of four distinct domains or areas in which learning environments can vary. These domains, presented in Figure 1, have been labeled Affective, Perceptual, Symbolic, and Behavioral.

An affective domain includes situations where that which is being learned is non-paradigmatic, soft and humanities-based. Figure 1 indicates that this can be contrasted with the symbolic domain, where learning is hard, science-based and paradigmatic. On the other hand, the perceptual domain, which is identified as being pure and theory based, emphasizes the exploration and understanding of basic relationships between causes of events and phenomena. The perceptual domain is contrasted with the behavioral domain, where the emphasis is on practical use or application rather than understanding or theory. (Fry, 1978) Specific descriptive indicators for each of these learning environments, as identified by Fry (1978) and by our review of the literature, are presented in Table 8.

From$the descriptors of learning environments in Table 8, we can see that the environments which best support the various learning abilities are summarized as follows:

- symbolic environment supports learners whose best learning ability is abstract conceptualization;
- perceptual environment supports learners whose best learning ability is reflective observation;
- affective environment supports learners whose best learning ability is concrete experience;
- behavioral environment supports learners whose best learning ability is active experimentation.

By examining earlier findings about the optimal learning ability (determined by examining the differences in the learning dimensions) of training participants, approximations can be made in determining the most appropriate learning environments for a particular group of management types. Table 9 indicates the most appropriate and second most appropriate learning environment for each management type of both the Facilities Division and Probation Division personnel.

Table 9 indicates that the most appropriate learning environment for upper management field personnel in the Facilities Division is a behavioral environment (see Table 8 for a description of a behavioral learning environment) that allows upper managers to learn with their best learning ability, active experimentation. In addition, Table 9 indicates that the symbolic environment (see Table 8 for a description of a symbolic learning environment) most closely approximates the needs of the rest of the Facilities Division and Probation Division field personnel, since they have varying degrees of abstract conceptualization as their strongest ability. By custom designing courses using the most appropriate learning environment for a particular management type, the highest levels of efficiency can be obtained.

Based on the findings summarized herein, training staff in the Georgia Department of Corrections may wish to modify the design, method of presentation and instructional activities of certain courses in the Management Development Training Program. For example, when implementing a course for upper managers in the Facilities Division, the learning environment should be primarily behavioral in nature, allowing these managers to utilize their best learning ability and preferred instructional activities (active participation types of activities such as case studies, simulations). However, when implementing this same course, for example, with supervisors in the Probation Division who have abstract conceptualization as their strongest learning ability, the course should be revised to suit the Probation supervisors preference for abstract information and instructional activities that support their need to practice their use of theory and analytical skills.

The present researchers believe that trainers and instructional designers must become aware of the predominant learning abilities of their training population. Moreover, they should become familiar with the most appropriate learning environments that best support a particular learning ability. As a result, training programs can then be designed and implemented to optimize their success. With some basic understanding of the learning styles of a training population, learning environments can be planned, instructional methodologies chosen, and media selected to best meet the needs of the learner. Recently, staff trainers, using recommendations from this study, modified the instructional activities and presentation methods of a management training course for Facility Division upper middle level managers. Though a formal evaluation has yet to be completed, comments by the students indicated that the program was highly successful: "the best training I've ever had...I learned a lot" (Allen, 1990).

Summary

The LSI data obtained from this study's training participants can be used in numerous ways by training staff. Methodologies and media approaches can be planned to meet the needs of the training participants. Furthermore, the data can be used during the training session to make revisions in the presentation of material or assignments to participants.

Based on information contained in this report pertaining to learning styles, learning environments, and instructional activities, trainers can utilize different approaches for different groups of training participants when delivering the instructional material contained in the new Management Development Training Program.

Table 8. Descriptive Indicators of Learning Environments

	TYPE OF ENVIRONMENT	
CATEGORY OF INDICATOR	AFFECTIVE	PERCEPTUAL
Objectives:	Basic purpose is to experience an event or activity, to be aware of one's feelings while going through it.	Basic purpose is to understand something, to know how and why things relate to each other.
Principal focus or source of information being dealt with:	Information is here and now, in the form of personal feelings, values, opinions, ideas, etc.	Information is derived from examining how and why something occurs, focusing on the process, reviewing past events.
Nature of feedback and rewards:	Feedback is personalized, based on each individual's own needs and learning goals.	Learner determines criteria for evaluation; and is left to determine own criteria for performance
Nature of learner's role:	Learners freely express personal feelings, opinions and values concerning topic or activity in which they are engaged.	Learners are encouraged to observe, listen, write, think, discuss, etc. in order to deter mine meaning and relevance of subject matter for themselves.
Teacher Role:	Teacher models the desired or appropriate behavior such that learners learn by example and through relating (identifying) with the teacher.	Teacher is non-directive, reflective, and nonevaluative and teaches by helping the learner to discover his her own perspectives, insights.
Instructional Activities and Enrichment Components:	Laboratories, observations, primary text reading, simulations, games, field work, trigger films, readings, problem sets, examples, structured activities.	Journals, logs, discussion, brainstorming, thought questions, rhetorical questions, role playing, causal models, advance organizers, compare contrast.
Learning Ability Best Supported:	Concrete Experiencer	Reflective Observer

	TYPE OF ENVIRONMENT	
CATEGORY OF INDICATOR	SYMBOLIC	BEHAVIORAL
Objectives:	Basic purpose is to solve a problem, to obtain a solution through use of theory and analytical skills.	Basic purpose is to apply knowledge to practical problems such as one would experience as a professional.
Principal focus or source of information being dealt with:	The source of information is abstract or there and then, derived from readings, lecture inputs, compiled data, etc.	Focus of information is on what and how to get task done, derived from previous work, plans, critiques, evaluations of progress, preparing for a presentation
Nature of feedback and rewards:	Performance is evaluated against right or best answer as judged by the body of knowledge or the teacher's expert opinion.	Output is evaluated against criteria of practicality, feasibility, sellability, etc.
Nature of learner's role:	Activities and communications are governed by of inference, methods, terms, etc. often subject to learners memory recall.	Learners make own decisions about use of rules' their time. Choice and actions at one point in time influence what occurs next.
Teacher Role:	Teacher is the expert authority, interpreting the field of knowledge or judging what is correct, competent, acceptable performance. Teacher may also be an enforcer of methods stipulated by the body of knowledge he represents.	Teacher is a consultant or coach at the learners request in order to advice or impart his knowledge of the field he represents.
Instructional Activities and Enrichment Components:	Lectures, papers, printed materials, model building, projects, practice, presentations, feedback, analogies, repetition.	Simulations, case study, laboratory, field work, projects, homework, group discussion, demos, structured activities.
Learning Ability Best Supported:	Abstract Conceptualizer	Active Experimenter

Table 9. Means of Learning Style Dimensions Indicating Best Learning Ability with Most Appropriate Learning Environments for Facilities Division and Probation Division Personnel by Management Type

Management and Division Type	Learning Style Dimension of Learner and Most Appropriate Learning Environment			
	AC-CE Mean	Appropriate Learning Environment	AE-RO Mean	Appropriate Learning Environment
Upper Facilities	-.09	2) Affective	7.00	1) Behavioral
Upper Mid Facilities	7.50	1) Symbolic	-3.42	2) Perceptual
Middle Facilities	4.61	1) Symbolic	-.47	2) Perceptual
Supervisor Facilities	3.87	1) Symbolic	-.36	2) Perceptual
Upper Probation	5.42	1) Symbolic	-1.26	2) Perceptual
Supervisor Probation	10.77	1) Symbolic	-3.50	2) Perceptual

Note. 1) indicates most appropriate learning environment; 2) indicates second most appropriate learning environment.

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Selected Formal Papers from the

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THE USE OF TELECOMMUNICATIONS TECHNOLOGIES IN LEARNING ENVIRONMENTS: PRESENT AND FUTURE

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Abstract

For several years, telecommunications technologies have been used successfully in the delivery of instruction and in other educational environment activities. Leadership in the use of these technologies has often come from the state level. This paper will examine what some states are currently doing and explore some future models.

Introduction

There was a time not many years ago when the term "telecommunications" was used to refer to a technology that was used exclusively by the telephone company in the transmission of voice or character data as with the telegraph. The development of FNX technology expanded telecommunications to include the transmission of picture data over telephone lines. The creation of broadcast technologies broadened telecommunications to include media other than the twisted pair. The computer age further broadened the term's meaning to include the transmission of digital data between machines that wave in close proximity to each other or separated by large distances. Satellites have played a major role in the expansion of the meaning of telecommunications.

Today, telecommunications and its related technologies play an increasingly significant role in the lives of all human beings. New applications and technologies are being continuously developed. These applications include the delivery of instruction; in school and training environments.

Leadership in the use of telecommunications for learning applications has come from a number of sources in the public and private sector. In the public sector, significant leadership has often come at the state level. Some examples of state leadership include what has been done and is currently in progress in Kentucky and Indiana, to name but two.

This paper will examine what these two states have accomplished in their educational environments through the use of telecommunication technologies. It will then present some possible future ways that these technologies can be used to provide more effective learning environments.

Applications of Telecommunications in the States

A number of states have made extensive use of telecommunications to improve their learning environments. These applications have come at all educational levels: elementary, secondary, college/university, and adult continuing education.

The Commonwealth of Kentucky is one of the more interesting and progressive states in the use of telecommunications. Kentucky has some areas of fairly dense population but it is basically a rural state. Many of the school systems in the state are organized on a plan based or a county-wide configuration; at that, many of the systems have less than 1000 students in grades K-12. Because of this student body size, many systems simply have not been able to provide the variety of curriculum offerings that would allow students to successfully compete for scholarships in higher education. Because of financial constraints, school systems could not hire the quantity or quality of teaching professionals needed.

The state recognized that telecommunications could help relieve its educational crisis in 1966 when its legislature created the Kentucky Educational Television network (KET). The thrust of KET was aimed at the elementary school and provided "in-school" programs in a number of subject areas. The original transmission technique was the use of microwave transmitters and telephone lines. Network television in the state was fed throughout the state in the same manner.

KET went on the air for the first time in 1968 and has been there ever since. Transmitted from studios in Lexington, programming soon spread to the secondary level and, in the mid 1970s, to higher education and adult continuing education. The transmission technique then moved to the use of microwave transmitters on the Kentucky Early Warning System (KEWS) as the carrier. To alleviate problems caused by the heavy demand for programming and the limitations of the capacity of the microwave/KEWS system, the 1988 state legislature authorized the creation of the Star Channel which could be broadcast via satellite. The same legislature also funded the purchase of a downlink dish for every school building in the state; the last of the dishes is to be installed by August 1990.

A significant activity of KET today is the delivery of advanced placement courses such as calculus and physics. Thus, many more students are able to take these courses where the opportunity did not exist before.

The creation of the Star Channel has freed up the KEWS backbone for greater use by higher education in the state. Several state universities (Kentucky, Louisville, and Wester Kentucky) have also added satellite uplink capabilities and anticipate increased programming with this medium.

A number of telecourses are now being offered for undergraduate and graduate credit by state universities and community colleges through KET. There is continuous demand for more offerings. At some installations on the KEWS network, students have the capability of "call back" to a live program in a teleconferencing mode format. These capabilities will be extended to more sites across the state in the future.

Western Kentucky University has been a leader in innovative delivery techniques. One of its telecourses was recently offered via KET at the same time the course was being taught live on campus. Western, in cooperation with A T & T, has successfully tested a two-way video capability between its campus in Bowling Green and its campus site in Glasgow, forty miles away. The system uses video comparison techniques on a dedicated line between the two sites. The instructor is able to see and hear the students at the same time as being seen and heard by the students. At present, the system is not yet operational because of budget constraints within the university but has a hope for future funding.

Like its sister institutions, the University of Louisville and the University of Kentucky, Western has the capability of uplinking telecourses not only to KET but to nearly any remote site in the world. Ongoing discussions on the feasibility of such a program continue to be held, but no definite plans have been made other than for KET. But, the possibility exists.

Western is also studying the feasibility of creating video, audio and data linkage across its campus utilizing cable television and fiber optic technologies. Academic and entertainment programs could be accessed from many different offices and dormitory rooms. The communications network would also link various computer networks across campus together through the use of bridges and gates.

The State of Indiana has taken a slightly different approach to the use of telecommunications. The impetus there has come from the institutions of higher education, primarily Indiana University, Purdue University and Ball State University with support at the state level.

Perhaps the first use of telecommunications in the state came from the IMPATI project at Purdue University in the 1950s. This project transmitted television programs to elementary and secondary schools from a DC-3 airplane which was airborne over the central part of the state. Programming covered a variety of disciplines and had some success. Lack of funding eventually caused the project to be discontinued.

In the 1960s, the state funded two new projects, both of which exist and flourish today. The first was the creation of the SUVON (State University Voice Network). This project involved the use of microwave and telephone technologies that connected all public and private universities and colleges in the state into a state-wide voice communications network. Faculty and staff at individual institutions could communicate via a "local call" to other institutions of higher education in the state. In some locations, communications was possible to the local community in which the destination institution was located with a simple use of a dial tone. In later years (and currently) the network has been used for teleconferencing. It has also been used as a medium for computer communications. For example, the seven campuses of Indiana University use the SUVON network to communicate to the computing facilities at the main campus (in Bloomington) and at the IUPUI campus in Indianapolis.

The decade of the 1960's also saw the creation of the Indiana Higher Education Telecommunications System (IHETS). The system was created for the purpose of offering college-level and adult continuing education courses in a variety of disciplines throughout the state. The system featured the use of one-way video with two-way audio capability. Location of sites on the IHETS network has grown far beyond university/college campuses. Sites are also now located in hospitals and county extension service offices. A number of certificate programs have been offered to practicing professionals and an expansion of this service is anticipated.

To date, the IHETS network has functioned as a closed circuit network, that utilizes teleconferencing. Discussions are underway relative the use of cable and satellite for broader coverage. Satellite transmission is currently being used for some applications but is still closed circuit in nature. The use of two-way video is also being explored by IHETS.

The IHETS network is beginning to include programming to some secondary schools in the state. Ball State is currently providing this programming in several areas and it is expected that Indiana and Purdue will soon follow suit. Currently, the state is exploring ways of expanding state-wide education to school districts. It is examining models such as the one in Kentucky but a concentrated effort at the state level is not expected momentarily.

Kentucky and Indiana are but two examples of how telecommunications are being used on a state-wide basis to provide richer opportunities for citizens in the state. Different models have been used by the two states but interest is growing as the potential of telecommunications technologies continues to be recognized. In both cases, the primary barrier is cost. The effect of this barrier remains to be seen in each individual state.

The Future

What is the future for the delivery of instruction via telecommunications technologies on a wide scale basis? The cost of implementation of these technologies will decrease and become more affordable. Delivery techniques will improve; the development of feasible two-way video will be a major factor.

Let us speculate for a few moments on some possible scenarios. Students will be able to interact visually and orally with their teachers from remote sites, just as though in the actual classroom. Students in English composition courses will be able to transmit their work to their instructor electronically with immediate feedback and instruction. Computer science students will be able to interact on a regular time basis with their instructors from computer systems. More and more programs will be offered to students at upper educational levels as the potential of full two-way video is realized. Educational opportunities will truly become available to everyone.

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AN INTERACTIVE TELECOMMUNICATION NETWORK TO SUPPORT EDUCATORS: A PRELIMINARY REPORT ON THE VEIN PROJECT

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Abstract

The Video Education Interactive Network (VEIN) currently being established by the University of Wyoming, the Wyoming Goodlad School-University Partnership, and private business represents a collaborative effort to improve teacher preparation and practice through the use of telecommunication technologies. Goals, development concerns, and anticipated uses of the VEIN system are reviewed. Recommendations for similar collaborative projects designed to support preservice and inservice teacher education are included.

Introduction

The nation has called for reform at all levels of public education, demanding that our new teachers receive more extensive preparation in the content areas for which they will be responsible. It is common knowledge that good pedagogical practice must be acquired simultaneously with this content area expertise. In order to prevent new teachers from engaging in instructional malpractice for years before developing real teaching skills, pedagogy must be embedded in undergraduate education programs and a coaching or mentoring system must be available to preservice teachers which will also support them throughout their initial years as professionals.

In the best of all possible worlds, this support could take the form of an experienced professional who would serve as a mentor/coach to student teachers. A mentor/coach would be readily available to student teachers and would be able to observe and interact with them frequently while preservice teachers were engaged in classroom activities with learners. Though observation and feedback is included as a standard component in the supervision of student teachers, current methods which rely on the presence of a live supervisor or on the use of videotaped lessons typically provide feedback after the student teacher has completed his or her interaction with students. Too often, post-hoc suggestions made to student teachers have little opportunity to be incorporated into practice or to be tested by preservice teachers in a supervised environment.

An alternative approach to the live supervision and mentoring of student teachers being examined at the University of Wyoming will utilize the capabilities of telecommunications media to provide students with almost instantaneous feedback on their pedagogical practice. The scenario envisioned is not unlike the way in which information is exchanged between the referees, the players, and the instant replay booth in a professional football game or the the way in which diagnostic and intervention strategies are used by a surgical team in a modern hospital. A student teacher's classroom is a serious clinical laboratory setting where coaching, mentoring, and the exchange and management of visual and audio information must occur in order to produce outstanding teachers. A network which provides real-time voice and video exchange is required to provide the channel for such an interactive mentoring/coaching system for preservice teachers. Such a system has potential for a multitude of other teacher-training applications, particularly as a support for new teachers among whom the drop out rate within the profession is quite high.

Efforts to incorporate telecommunication technologies in the support of student teachers (Johnson and Clawson, 1989) and beginning practitioners (Rodman, 1989) suggest that supervision, mentoring, and coaching can be accomplished from a distance by coordinating the efforts of student teachers, cooperating professionals, and college faculty. In Wyoming, a state where vast geographic distances separate population areas, attractive incentives exist to test the potential of telecommunications technologies to support student teachers and beginning professionals. For example, the College of Education at the University of Wyoming actively is seeking alternative approaches to improve teacher education and is investigating the opportunities provided by telecommunications technologies to expand student-professor interaction across the state. Another incentive for testing the potential of technology to support teacher preparation is the fact that, as a member of the Goodlad School-University Partnership, the College works closely with public school districts in Wyoming to improve the quality of education within the state and across the nation. The Wyoming Goodlad Technology Task Force currently is focusing on the potential of telecommunications to provide alternative educational opportunities. This existing working relationship among College faculty and public school administrators and teachers, along with their common interests in the potential uses of telecommunications to improve teaching and learning, led to a natural collaborative venture triggered in part by the opportunity of partial funding through a grant from private enterprise. To achieve reform in education, collaborative ventures between all levels of education, as well as business and government, are needed to create networks for the training and development of professionals and to identify sound methodologies for the incorporation of information technologies into our educational system.

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Several factors contribute toward making the College of Education at the University of Wyoming a key location for a demonstration project of this nature. The University of Wyoming offers the only four year teacher training program in the State. Practicing professionals in the State are separated by vast geographic areas making it difficult for them to network resources with the University. The College is in the process of restructuring its preservice teacher education, adopting a change-based model. Part of the change-based model involves teacher training in the use of new information technologies. The College has already established a strong human network of educators through the Goodlad School/University Partnership Program. This human network has produced substantial positive differences in the schools and in the University's Teacher Education Program. The University has committed itself to help expand and enrich the curriculum in Wyoming's public schools. The College plans to participate, at many levels, in some of the already existing and effective information exchange networks such as the Big Sky Telegraph system. These systems are making possible the exchange of information between our educational institutions, government agencies, agricultural extension network, and businesses in isolated communities. Our teachers and children must be educated to utilize such systems if they are to be prepared to serve our increasingly information oriented society in productive ways. The availability of information networks and people who are knowledgeable about their uses also provides attractive incentives for businesses to locate in areas where these resources are available.

The College of Education, with its Laboratory School and its commitment to the Goodlad Project provides an ideal setting in which to create a demonstration program. The program can be used as a resource to attract additional funding to involve nationally recognized scholars in educational research and grant writing, and to entice other institutions to engage in collaborative teaching and research efforts. The proposed Video Education Interactive Network (VEIN), should serve as a continually expanding resource which will become self supporting through its ability to attract new sources of funding. It will become a laboratory for the integration of new technologies in preservice experiences, teaching, learning, research, faculty development, and inservice education. This paper represents the preliminary summary of the Video Education Interactive Network (VEIN), a collaborative demonstration project for the improved support of preservice and beginning teachers.

Project Goals

The initial focus of this project is the collaborative development of a real-time two-way voice and video network to improve teacher education. The VEIN Project first will target the development of a mentoring and coaching system for student teachers. Specific goals include but are not limited to the following outcomes.

When compared with student teachers participating in the traditional student teaching program at the University of Wyoming, student teachers participating in the VEIN program will:

1. be more adept at teacher decision making.
2. be more highly skilled at diagnosing individual student dilemmas.
3. demonstrate enhanced communication skills.
4. be better able to diagnose individual learning style preferences.
5. be more likely to use mentoring/coaching techniques with their own students.
6. be more likely to incorporate the use of technologies in their own classrooms.

After the first phase of the VEIN Project has been evaluated and revised, expansion of the network will involve the creation of a teacher support system for first- and second-year teachers and eventually the VEIN Project will evolve to include in-service support for more experienced educators. An additional long-range goal of the VEIN Project is the development, dissemination, and evaluation of instructional strategies with which classroom teachers should be familiar in order to appropriately integrate telecommunication technologies into their classrooms. It is critical that the instructional applications of new technologies be incorporated into teacher education programs so that teachers learn how to use technologies to improve educational experiences for our nation's youth.

The VEIN Project is being continuously evaluated on its effectiveness in providing a teacher support network and its potential for expansion to meet other needs. As it evolves and develops, the VEIN Project will be expanded to test its potential for enhancing educational practice in the following ways:

1. Create a much stronger educational system at all levels within the state by providing a means for the networking of a range of resources.
2. Provide preservice and practicing teachers with an opportunity to gain expertise with the integration of telecommunications media as part of the teaching/learning process.
3. Provide learners with an opportunity to gain experience with telecommunications media as part of the teaching/learning process.
4. Provide opportunities for students at geographically separated schools to engage in cooperative learning activities.
5. Impact the integration of technology into classrooms in other states given the fact that 70% of the College's students leave to go to 41 other states.
6. Facilitate cooperative teaching and learning programs between the College and school districts around the State and the Nation.
7. Provide new opportunities for faculty development and in-service experiences and allow for interaction between teachers who

might otherwise have a very limited peer group.

8. Facilitate one-on-one delivery for the developmentally disabled.
9. Help expand and enrich the curriculum in Wyoming's public schools by delivering content from the University to districts which can not afford to hire teachers for certain subject areas. Advanced students in Wyoming's high schools could simultaneously take courses with college students at the University.
10. Enhance collaboration between the Colorado Goodlad School-University Partnership and the Wyoming Goodlad School-University Partnership. The laboratory schools at the University of Wyoming and Northern Colorado University could become a national laboratory school for other teacher education programs.
11. Allow the Goodlad Partnership concept to be expanded to include the private sector.

Development and Implementation Issues

Several factors have contributed to the collaborative development of the VEIN Project. Practicing professionals in Wyoming are separated by vast geographic areas making it difficult to network resources. However, the Wyoming Goodlad School-University Partnership has promoted interaction among the College of Education and school districts across the state. The University and the participating Goodlad districts are committed to expanding and enriching the curriculum in Wyoming's public schools. Part of this commitment targets improving experiences for preservice teachers and includes incorporating the uses of instructional technologies into teacher training programs and classroom practice. The cooperative network and common goals already established among the Goodlad School-University participants facilitated the development of the VEIN Project.

The College of Education, the University of Wyoming, and the Goodlad school districts were prepared to make fiscal and programmatic commitments to improving student teaching experiences through the use of telecommunications. The financial support provided by private business demonstrates the interrelated concerns shared by public schools, higher education, and business in developing the role which instructional technologies play within the educational system. Programmatic commitment to the VEIN Project is demonstrated by the willingness on the part of the College and school districts to work together to develop distanced mentoring/coaching/supervisory experiences for student teachers. These particular concerns are elaborated below.

Required Technological Resources. Each participating institution must have access to a video compression unit ranging in cost from $18,000 to $30,000, depending upon the quality of video desired. Additionally, each participating institution must be prepared to share the costs of leasing either a fiber optics or T1 land line for transmission of the compressed video and audio information. Because of the relatively expensive cost ($6,000 to $12,000 per month depending upon the quality of video signal required) collaborative efforts between public institutions and the private sector are extremely advantageous. The VEIN Project is based upon this type of collaboration.

Coordinating Student Teaching/Mentoring Experiences. A major issue involves the coordination of students, faculty, master teachers and school districts. Under the present live visitation model being used at the University of Wyoming, site visits are made during the student teaching experience by College field-based faculty who coordinate their visitations with the master teachers in a school district. The VEIN Project supports the direct involvement of students on campus in Laramie with master teachers in eight districts around the State prior to student teaching. These students will team teach with master teachers using the two-way audio and video network. Topics for team teaching are collaboratively identified by methods classes on campus and participating teachers at the network sites. Students identify a topic and consult with the practicing professional associated with that topic. Once the lesson is prepared students on campus use the VEIN network to team teach the lesson with their cooperating teacher.

Technology Training. Telecommunications training for faculty, students, and master teachers is important in the sense that they must be familiar enough with the technologies involved to make the systems being used seem almost transparent. That is, the technology should interfere as little as possible with the accomplishment of the instructional goals. An interesting lesson was learned during a demonstration of the compressed video portion of the network on August 2 and 3,1990. A rehearsal with the equipment was held on August 2, and two one-hour demonstrations were conducted on August 3 for the University of Wyoming Board of Trustees' Symposium. By the second demonstration, the grade-school students, classroom teachers, student teachers, and faculty members involved in the demonstration were almost completely at ease with the system. The most difficult feat to accomplish was to dispel the mindset that the system could only send or receive information. Once participants found they could interrupt each other and engage in true interaction, the technology became nearly transparent after only a few hours of experience with the system. It became quite apparent, however, that technical support be provided so that the users do not have to worry about operating the system they are using.

Trouble Shooting and Technical Support. A discussion of technical support leads to issues concerning the trouble shooting of the technology If a technician is available to users, the equipment can be maintained and the system adjusted by the technician should operating difficulties occur. Providing technical assistance helps in trouble shooting if any glitches occur, but also helps encourage the use of technologies. If people have a high level of anxiety about using the equipment, they are less likely to use the system. If people do use the system, it is likely they will not be relaxed enough with its use to gain the full benefits possible, and technical support lessens these concerns. Experience with the VEIN demonstration sessions indicates that money spent to provide technical support for the system is a wise investment.

Evaluation and Educational Importance

The development of a telecommunication-based mentoring/coaching system for student teachers is the first goal of the VEIN Project. The project will undergo continuous formative evaluation and subsequent refinement in order to maximize its effectiveness and efficiency for all participants involved in the collaborative effort. An advisory committee has been formed consisting of representatives from the public schools, community colleges, the University of Wyoming, and the private sector to assess the degree to which the objectives of the VEIN Project outlined above are being accomplished. Recent criticism of teacher education has included recommendations for additional research on increased experience-based or clinical experiences prior to student teaching. The level and significance of research on the effectiveness of increased clinical experiences earlier in teacher preparation programs is limited. The VEIN Project provides an opportunity to study numerous issues related to the improvement of teacher education and practice in the schools. A range of qualitative and quantitative research methodologies and research designs can be supported through the VEIN system. The results of such research may be more directly applied to the improvement of schools and teacher preparation.

Summary

The initial focus of the VEIN Project is the collaborative development of a real-time two-way voice and video network to improve teacher education. The VEIN Project first is first targeting the development of a mentoring and coaching system for student teachers. After the first phase of the VEIN Project has been evaluated, expansion of the network will involve the creation of a teacher support system for first- and second-year teachers and eventually the VEIN Project will evolve to include in-service support for more experienced educators. An additional long-range goal of the VEIN Project is the development, dissemination, and evaluation of instructional strategies with which classroom teachers should be familiar in order to appropriately integrate telecommunication technologies into their classrooms. It is critical that the instructional applications of new technologies be incorporated into teacher education programs so that teachers learn how to use technologies to improve educational experiences for our nation's youth.

Several factors have contributed to the collaborative development of the VEIN Project. Practicing professionals in Wyoming are separated by vast geographic areas making it difficult to network resources. However, the Wyoming Goodlad School-University Partnership has promoted interaction among the College of Education and school districts across the state. The University and the participating Goodlad districts are committed to expanding and enriching the curriculum in Wyoming's public schools. Part of this commitment targets improving experiences for preservice teachers and includes incorporating the uses of instructional technologies into teacher training programs and classroom practice. The cooperative network and common goals already established among the Goodlad School-University participants facilitated the development of the VEIN Project.

The College of Education, the University of Wyoming, and the Goodlad school districts were prepared to make fiscal and programmatic commitments to improving student teaching experiences through the use of telecommunications. The financial support provided by private business demonstrates the interrelated concerns shared by public schools, higher education, and business in developing the role which instructional technologies play within the educational system. Based on demonstrations already conducted, technical support, practice with the system, and hands-on use by practicing educators, student teachers, faculty members will contribute to the success of the VEIN Project. This commitment to the VEIN Project is demonstrated by the willingness on the part of the College and school districts to work together to develop distanced mentoring/coaching/supervisory experiences for student teachers.

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TEACHING TELECOMMUNICATIONS: PROMOTING PRACTICE AND POTENTIAL

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Abstract

Issues concerning the integration of telecommunications technologies into educational practice are addressed from the perspective of students, instructors, and seminar participants who were involved in a course in *Instructional Telecommunications.* Suggestions for the design and implementation of similar college courses include the use of practical, hands-on activities, an emphasis on design and development aspects of using telecommunications systems for instruction, and attention to principles of change agentry. These guidelines also appear to be appropriate considerations for those people interested in promoting the use of telecommunications media in classrooms and other instructional situations.

Introduction

The term *telecommunications* is filtering more frequently into the conversations of educators. Though some observers (Hudspeth and Brey, 1986) point out that inertia tends to slow the adoption of telecommunication media within school systems, they also stress the potential contributions which telecommunication technologies can make to the instructional process. Others (Roberts, Blakeslee, Brown, and Lenk, 1990) offer a more positive assessment of the rate at which telecommunications media are affecting educational practice and underscore the need for professional educators to become familiar with the instructional capabilities of telecommunication systems.

Though current trends reflect an awareness of the potential of telecommunications to affect educational practice, a myriad of unanswered questions remain concerning the "whys" and "how-to's" of integrating telecommunications into education. In addition, the definition of *telecommunications* itself is unclear, as technological developments offer an increasing variety of delivery media and enable users to combine elements of telecommunication systems in unique ways. If educators are to take advantage of these new telecommunication technologies, they must not only become aware of the potential uses of the technologies and acquire basic operational knowledge of the telecommunication systems, but they must also address associated instructional design issues, be familiar with system limitation and strengths, determine instructional strategies, and focus on appropriate learner outcomes that will be facilitated by the incorporation of telecommunications into the classroom.

Though telecommunication systems no doubt are appropriate for instructional situations outside of the traditional K-12 context, a primary mission of the College of Education at the University of Wyoming is to prepare teachers to assume responsibilities in the public schools at these levels. Toward this end, a graduate course in instructional telecommunications was designed to help prepare teachers and other educators to incorporate telecommunications into their instructional situations and to help their colleagues do likewise. This paper deals with development concerns associated with the telecommunications course; relates successes and frustrations encountered during the semester; offers recommendations for the design and delivery of similar courses; and enumerates suggestions from students, instructors, and other educators for integrating the use of telecommunications in public schools and higher education.

Course Description and Course Development Concerns

The *Instructional Telecommunications* course taught during the Spring Semester of 1990 was designed to familiarize students with a variety of current instructional telecommunications systems. The following concerns were discussed for each of the systems studied in class: 1) system capabilities, 2) hardware and software requirements, 3) costs, 4) management requirements, 5) instructional advantages and disadvantages, 6) instructional strategies and skills appropriate for each system, and 7) implications for instructional design. The telecommunications technologies targeted in this course included: 1) satellite and microwave, 2) audio and audiographic, 3) compressed video, 4) computer-based networks, and 5) closed circuit and cable. A primary goal was to design a course that was hands-on and that would allow educators to gain experience with telecommunications systems actually being used in the state. The selection of the five systems mentioned above reflects the use of technologies actually available for hands-on use at the University of Wyoming and in some of the K-12 schools across the state. The integration of these and other technologies to form additional "hybrid" telecommunication systems also was discussed during the course.

During the semester, students investigated each of the five types of telecommunications systems enumerated above in relation to each of the seven concerns listed. A goal of the course was for students to gain basic familiarity with a variety of telecommunications systems. An additional goal was for students to demonstrate basic operation of two of the

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telecommunication systems as part of a group project. Successful completion of the group project included the development of seminars dealing with instructional applications of the telecommunications technologies with which the student groups had become familiar. These group seminars were presented to College of Education faculty and students, and the group members actually used the technologies being discussed to present the content of the seminar. Therefore, group members not only discussed instructional issues concerning each of the telecommunications systems, but also demonstrated appropriate design and delivery strategies associated with each technology. As a result, students enrolled in the *Instructional Telecommunications* course served as role models and change advocates for their colleagues in the College as they demonstrated the instructional potential of the telecommunication systems.

The student-delivered seminars were included in the course for a dual purpose. The first was to help students realize the critical nature of the instructional design process when using telecommunications technologies for educational purposes. Too frequently, students focus on the operation of the hardware itself and not on the ways in which technologies can be used to enhance instruction. The seminars encouraged students to think about important instructional attributes of the technologies and to share this information with others in the College. These seminars also helped accomplish another goal which was to make telecommunications technologies more visible within the College and to stimulate the interest of faculty and students in the instructional potential of these delivery systems. The seminars were videotaped and will be available to faculty and students for independent viewing and for faculty development.

Additional class activities required students to analyze instructional situations, to specify what types of telecommunications systems they would incorporate to meet the instructional needs described, and to justify their choices of delivery systems. In doing so, students discussed current research and practice associated with instructional telecommunications systems. Required readings included *Instructional Telecommunications: Principles and Applications* (Hudspeth and Brey, 1986) and numerous readings selected by students themselves. In the process of preparing the group seminars about specific systems, each group of students assembled key readings on that particular technology and these resources were shared with the other members of the class. In addition to a variety of readings, lectures, and seminar presentations, instructional activities also included numerous site visitations, hands-on sessions with hardware and software, and discussions with guest speakers, many of which were conducted using audio teleconferencing technologies. Again, course activities were designed to provide students with opportunities to become aware of a variety of telecommunications technologies and to encourage students to think about the potential of using these delivery systems to provide richer educational environments.

Successes

A major goal for the course was to provide students with opportunities to become familiar with the hardware aspects of telecommunications systems as well as with the particular design and development issues which facilitate the instructional uses of the technologies. Though the hands-on-the-hardware approach utilized in the course attracted many students at the onset, students also rapidly realized the importance of learning not only how to operate the equipment but of knowing how to plan for and carry out instructional telecommunication sessions. Students demonstrated the use of technologies and also modeled appropriate ways to address design and delivery issues associated with the use of telecommunications. The importance of maintaining this balanced approach to incorporating telecommunication systems into educational environments proved to be one of the greatest "truths" which emerged during the semester. From the perspective of both the students and the instructors, one of the successes of the course was that students realized the critical importance of the instructional design process when telecommunication technologies are used to deliver instruction.

The course was also successful in increasing student awareness of and enthusiasm for the use of telecommunication technologies in the educational environment. Student evaluations of the course showed that most class participants had begun the semester with little or no knowledge of instructional telecommunications. Most students also admitted that prior to the course they had been intimidated by the technologies themselves. Student feedback indicated that class participants felt more comfortable with and more knowledgeable about instructional telecommunication technologies by the end of the semester. In fact, the course seemed to have a residual effect on several students. As one student commented several months after the class, she "didn't realize it then" but she had learned enough during the course to be able to make significant contributions to a discussion about telecommunications that had evolved during an adult education course that the student took the following semester. Another student confided that, months after the course, she had felt confident about her responses to questions regarding telecommunication technologies that had been posed during her successful interview for a position as an elementary library media professional. Course evaluations and student testimonials indicate that the course was successful in lessening student anxieties about telecommunication technologies and in increasing student knowledge and enthusiasm.

Another successful aspect of the course was the hands-on nature of the class. Students valued the opportunity to gain practical experience using a variety of technologies. By preparing and delivering group seminar presentations, students encountered first-hand many of the difficulties in using telecommunication technologies. Of particular interest were student comments that reflected their understanding that not only facilities and technologies are necessary to support instructional telecommunication endeavors, but that human resources are a critical factor as well. Instructors and students had discussed this issue in class, but the importance of human resources became much more apparent when students began actual hands-on development and delivery activities using the technologies. Instructors and students were fortunate to have the support and cooperation of many key people both inside and outside the College of Education as well as outside the University of Wyoming. As students soon learned, these human resources were essential to the success of their telecommunication endeavors and to the overall success of the course.

The group seminar presentations provided students with hands-on experience using telecommunication technologies from the perspective of an instructor or instructional designer, but the course also provided class participants with an opportunity to experience what "real students" would encounter during instruction delivered using a variety of telecommunications technologies. When seminar sessions were presented, the remaining class members experienced each of the delivery systems from a learner's perspective. In addition, audio teleconferences were conducted with DeLayne Hudspeth, author or the textbook, and Frank Odasz, director of Big Sky Telegraph, which provided students with an example of putting "theory" into practice. Telecommunication technology also was used to solve an unanticipated real-world problem that arose during the course. When the time scheduled for the oral portion of the final examination for the class arrived, one instructor and one of the students were ill, and one student was out of town for a job interview. The oral portion of the final exam was conducted using audio teleconferencing, enabling all students to participate in the final. Students commented that this activity was an appropriate conclusion to the semester. Overall, the practical, hands-on nature of the course contributed to its success in the variety of ways discussed above. Limitations of the course and areas in which the course can be improved are discussed below.

Recommendations and Caveats

The hands-on nature of the course was one of the greatest successes of the class, but providing this type of experience generated some concerns. One student lamented the lack of formal lectures and paper-and-pencil tests; however, the course instructors believe the majority of students appreciated the break from the "traditional" graduate course format. To succeed in the *Instructional Telecommunications* course, students had to become active participants. Students could not sit passively, take notes, and regurgitate information on a test. Instead, they had to locate resources, work in groups, plan seminars, and learn to operate hardware. Many students expressed an interest in having more hands-on experiences, particularly with the technologies other than those which they had studied in depth in preparation for the seminar presentations. Other students commented on both the benefits as well as the frustrations of working in groups. Benefits included sharing responsibilities and resources, while frustrations arose in scheduling meetings and in assigning responsibilities. Most of the students felt that the preparation of groups seminars was worth the minor frustrations encountered, particularly because the seminars offered the students an opportunity to make a real-world contribution to faculty and students within the College of Education. Though students were nervous prior to their seminar presentations, students commented that a sense of achievement and self-esteem resulted from the experience. tudents also were pleased that faculty members and fellow students had informally thanked them for organizing the presentations and had encouraged more seminars of a similar nature. Based on student feedback, when the *Instructional Telecommunications* class is offered in the future, the instructors again will develop a hands-on course and will more vehemently advise students that the course demands active participation. Instructors also will try to provide more time for students to individually use the variety of delivery systems available. Although expectations for group work and group processing strategies were discussed briefly in class, the instructors may also include more emphasis in this area. Finally, examples of frustrations and successes which students experienced in preparing and delivering the group seminars as well as feedback from seminar participants will be available to share with future students.

Feedback from the faculty and students who attended the seminars was extremely supportive of the sessions. Participants appreciated the real-world demonstrations of system capabilities. Participants would have liked to have had more time to manipulate the technologies themselves with the help of the presenters, and this recommendation will be passed along to students in future *Instructional Telecommunications* courses. Seminar participants also commented that the audience consisted of people with a diverse amount of technological experience and suggested that seminars be offered on beginning, intermediate, and advanced levels. These comments both frustrated and encouraged the students in the class, who had debated audience analysis issues, had weighed their group resources and constraints, and had chosen to present information for the novice and to advertise the seminars as such. Students in the course felt that time, resources, and audience analysis had indicated that novice sessions would be most appropriate, but they were pleased to hear that seminar participants were interested in additional and higher level presentations. In fact, numerous seminar participants suggested that all faculty members and students in the College would benefit from similar seminars. These statements encouraged the students, for, though the people who attended that seminars were enthusiastic, students who had prepared the seminars had been disappointed initially in the number of people attending which ranged between twenty and forty individuals per session. Course discussion regarding the process of educational change evolved naturally from these observations. Overall, participant feedback indicated that future students should continue the practical, demonstration-oriented perspective of the seminars but should attempt to provide participants with more hands-on experience with the technologies and to accommodate participants with varying levels of expertise.

Students in the course commented that they did not know how to deal with the participant recommendations that seminars be targeted for individuals of varying levels. Student groups had made conscious decisions to design seminars for a general, novice audience and were frustrated by the amount of information that had to be omitted from the seminars due to the one-hour format. The course instructors encountered similar frustrations when designing the class itself. Though the majority of students were unfamiliar with the variety of telecommunications hardware, individual students were quite familiar with a single technology. The instructors encouraged students already familiar with one of the technologies to participate in seminar groups involving delivery systems with which they were not well acquainted. Some student expertise was not tapped due to this request, but individual students expanded their experiences with the variety of technologies. Another frustration from the instructors' point of view was determining the focus of the course, for a class in instructional telecommunications could include a variety of topics. This course focused particularly on selected delivery systems and the associated instructional design and delivery considerations, skirting many associated issues related to distance education. Students included some of these related issues during seminar presentations, and class discussions related to the Hudspeth text briefly touched upon some of the more global aspects of instructional telecommunications. However, another entire course is being planned to focus on additional principles, applications, and examples of distance education and the related technologies. The perspective of the additional course will include issues addressed in texts such as *Readings in Distance Educations, Numbers 1 and 2* (Moore & Clark, 1989) and *Linking for Learning* (Office of Technology Assessment, 1989). The inclusive nature of the field of instructional telecommunications also provided the instructors with a challenge in the choice of textbooks. The Hudspeth text provided basic instructional design concepts and discussed administrative concerns with little emphasis on hardware issues, and students consulted current journals to familiarize themselves with the capabilities of the variety of hardware available. However, both instructors and students are still looking for an introductory text which consolidates information and issues in instructional telecommunications in one volume. Overall, instructors believe that the *Instructional Technology* course provided students with a basic understanding of what a variety of telecommunication technologies can do and of the design and delivery concerns associated with them so that students will be able to further explore the role of technology in distance learning in subsequent classes and in their educational environments.

Opportunities for Integration

During the semester, students in the *Instructional Telecommunications* class were asked particularly to be aware of ways to integrate telecommunications into classroom practice. Advantages and limitations of extant "packaged programs" such as TI-IN, Big Sky Telegraph, and CNN Newsroom were discussed. Students also investigated what educators needed to know in order to develop their own lessons and programs incorporating telecommunications technologies. The group seminar presentations provided students with an opportunity to "practice" promoting the use of telecommunications in one particular educational environment, namely the College of Education. In this "test case," students soon began to see the value of being familiar with strategies to promote planned change (Havelock, 1973; Rogers, 1982). For example, when presenting their group seminar sessions to faculty members and students within the College, students in the course observed typical trends in the adoption of innovations. Students noted that some of the individuals in the College demonstrated characteristics of innovators, early adopters, early majority, late majority, and laggards as described in Rogers' (1982) research on categories of those who adopt innovations such as telecommunications technologies. Also of primary interest to students in the class were the seminar participants' comments which indicated that perceived relative advantage, trialability, observability, lack of complexity, and compatibility were indeed characteristics (Rogers, 1982) that would increase the likelihood of the adoption of telecommunications technologies. For example, many seminar participants wanted to know how instructional telecommunications technologies would make their jobs as teachers easier or how they could teach better using the hardware (perceived relative advantage). Participants wanted to have opportunities to use the technologies themselves (trialability) and also wanted to see the various delivery systems working, particularly in situations similar to their own (observability). Seminar participants, perhaps initially overwhelmed by the less transparent delivery systems, felt that the telecommunications technologies were less complicated after seeing a demonstration and receiving some some hands-on experience (lack of complexity). And many session participants appreciated the emphasis on how the use of technologies could be incorporated into existing classroom practice (compatibility). From their seminar experiences, students in the *Instructional Telecommunications* course began to understand how efforts to promote the use of instructional telecommunications technologies could be planned and delivered taking advantage of principles and practices of planned change.

Class participants also began to focus specifically on the potential for introducing and establishing telecommunication technologies in their own instructional situations. Two members of the class were library media professionals and were interested in establishing computer-based information links in their school media centers. Other class members interested in corporate training focused on the potential of interactive audio and video technologies in business. The classroom teachers enrolled in the course were particularly interested in establishing computer-based networks in their schools, and wanted to explore the opportunities to provide students with additional courses and with access to information outside of the school distinct using interactive audio and video delivery systems. Each student developed areas of concern, but all students were impressed with the need to educate and excite colleagues about the potential of instructional telecommunications. As mentioned above, both the seminar participants and the students in the instructional technology course commented that the topic of telecommunications should be included in both graduate and undergraduate teacher education programs. Students in the course also advocated the use of telecommunications in the public and private schools. The common perception that instructional telecommunications will play an increasing role in education and that teachers should have both training in and access to these resources was not paralleled by a shared perspective of how this goal should be accomplished. Neither did students find definitive answers in the literature. As students in the *Instructional Telecommunications* course learned, the potential of instructional telecommunications to impact students, teachers, and other members of the educational system appears promising, but the means toward this end are still being investigated. Students found the principles of change agentry to be valuable tools for integrating telecommunications technologies into education. Students also observed that demonstrating the uses of telecommunications technologies and allowing potential users to gain some hands-on experience with the hardware lessened anxieties about using distance delivery systems for instruction. Based on experiences in the Instructional Telecommunications class, instructors also have begun to work with faculty at other institutions to develop an intra-university course in which students at geographically separate locations will investigate issues in telecommunications using the various delivery systems. Although much remains to be learned about the process for integrating telecommunications technologies into school systems, students in the *Instructional Technology* course believe telecommunications should be a priority item on the educational agenda and plan to incorporate some of the experiences and observations discussed above into their own instructional environments.

Summary

The potential for telecommunications to impact educational practice is a topic of current interest, and examples of how telecommunication systems support instruction are becoming increasingly visible. In order to integrate telecommunications technologies into classroom practice, teachers must be provided with encouragement to adopt new instructional approaches, assistance in utilizing new technologies, and support in planning, implementing, and evaluating instruction which incorporates telecommunication technologies.

In offering a hands-on course in *Instructional Telecommunications* for educators, it became apparent that efforts to integrate telecommunications technologies into classrooms will involve affective learning outcomes as well as focusing on the cognitive and psychomotor aspects of using the systems themselves. As students in the course observed, teaching educators how to operate the hardware and how to prepare and deliver effective lessons that will take advantage of the capabilities of distance delivery systems can only be accomplished after teachers have become aware of the potential of the technologies. Designing and presenting seminar sessions for members of the College of Education allowed students in the course to experience some of the rewards and frustrations often faced by those in the field of instructional telecommunications. Students learned that several strategies known to contribute to the adoption of innovations can be used to influence educators' attitudes toward the viability of telecommunications in the classroom and should be kept in mind when designing and implementing telecommunications training sessions. Students also found that emphasizing the design and development issues associated with the use of telecommunications technologies were of paramount importance in the preparation of their seminars, and design and development issues were of great interest to seminar participants as well. The use of demonstrations and hands-on activities also contributed to the success of the seminars. Similarly, both students and instructors of the *Instructional Technology* course felt that the emphasis on change agentry, instructional design and development, and practical experience were factors that contributed to the class itself. Though continuing modification of the course will occur, students, instructors, and seminar participants indicated that both the course and the seminars were valuable steps in the process of increasing educators' integration of telecommunications technologies into instructional practice.

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A HYPERTEXT APPROACH TO STRUCTURING COMPUTER-MEDIATED SEMINARS AND CASE STUDIES

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Abstract

This paper reviews earlier experiences with the use of e-mail as a simple basis for computer-mediated seminars. Several approaches to the construction of tools that assist participants in maintaining a structured view of the seminar over time are described. A pilot project that compares some of these tools is reported.

Instruction Versus Conversation: Two Contrasting Paradigms

We will not go deeply into the roots of the contrast implied by the title of this section. Suffice it to say that the main 'opposition camp' to the 'educational technology movement', since the days of programmed instruction and up to the present CAI systems, can be summarized by this title. A glance at Table 1 will explain what we have in mind. The instructional technology approach has been criticized on the grounds of; insisting on too specific, product-based and uniform objectives, and placing too much emphasis on prior design and development of materials by the 'system' followed by the dissemination of these standard messages to all students indiscriminately. It has also been criticized for overemphasizing behaviors mastered rather than ideas processed, for the correction of errors rather than reflection on the implications of viewpoints, and for being shallow and superficial rather than encouraging the processing of complex multifaceted content.

Whereas this cannot be levelled as an across-the-board criticism of the educational technology movement (not all work in our field has followed the 'instructional' paradigm, nor is this paradigm always inferior to the alternatives), it has tended to limit our field to those who did not have a total aversion to the concept of 'instruction' as defined in Table 1.

Today, with the communication systems available, teleconferencing has become a widely used, versatile and ingenious methodology. In the State of New York alone, more than 100 conventional educational establishments use some form of teleconferencing to supplement, or supplant, conventional face-to-face education. Few of these would become so deeply involved with self-instruction-based education. Part of the reason may be the clash of paradigms, mentioned earlier. But perhaps a more compelling set of reasons springs from practical and economic considerations. Armstrong (1990), Brockley (1990), and Chute (1990), show how in vastly different contexts, it is both relatively easy and relatively cost-effective to set up a teleconferencing-based distance education system. George (1990) argues that the use of teleconferencing is only slightly different from the small group learning activities that are so popular in face-to-face teaching.

Paradigm:	*'Instruction'*	*'Conversation'*
OBJECTIVES: (OUTPUT)		
(why?)	specific	general
	pre-defined	negotiable
	products	processes
	standard	variable
MESSAGES: (INPUT)		
(what?)	designed	created
(when?)	pre-prepared	on-line
(who?)	instructor	participants
(whom?)	one-to-many	many-to-many
INTERACTION: (PROCESS)		
(focus)	behaviors	ideas
(analysis)	criterion-ref	contents/ structure
(feedback)	corrective	constructive
(complexity)	one-layer thick	interwoven layers
DISTANCE EDUCATION:		
example	Correspondence courses	Teleconferencing
	Computer Mediated Communication (CMC)	Videoconferencing

Table 1. Instruction verses conversation

Finally, as Table 1 illustrates, teleconferencing fits naturally on the right hand side of the instructional/conversational continuum and so may be used in subject areas where many would consider the instructional paradigm to be less than ideal.

Computer-Mediated Communication

Sending messages from one terminal to another, even over international boundaries, is not new. Boyd (1990) points out that electronic mail and file transfer is as old as mainframe computers and was already quite widespread among scientists in the 1960s. However, only recently has it become a popular and relatively widespread means of communication for educational purposes. Judging by the quantity of literature on the topic that has been published in the last few years, this may well be the fastest growing area of application of technology to communication and education. Perhaps the most common way of using computer-mediated communication is for so-called computer conferences. These have many of the characteristics of teleconferences, except for the real-time aspect.

The asynchronous nature of the communication process in CMC, has been found of educational value in interactions between persons who are prevented from meeting face to face by distance. At Syracuse University we have, for some time, been supplementing classroom discussions by extended electronic mail interactions between students who are resident on campus and others who live further away. We have found that the e-mail discussions are often much deeper, much richer and involve a larger proportion of the student group than is typical in a conventional class-based discussion (Grabowski et. al., 1990). However, we have also found that the use of e-mail as such a discussion medium poses certain challenges to the instructor. Notable among these are keeping control over the direction of the discussion and helping participants to maintain an overall view of the structure of the debate, as it evolves over time. Several instructional strategies for dealing with these challenges have been experimented (Romiszowski & Jost, 1989).

There are many benefits claimed for using computer mediated communication in education: a democratic environment for group interaction and learning; a record of the entire course; students don't miss any of the instruction due to absenteeism or daydreaming; more students respond to questions and ideas; the responses are longer and more complex than in a traditional classroom; the students learn from each other; teacher comments become more interactive (Romiszowski & Jost, 1989).

A problem that needs to be addressed when using CMC as an integral part of a course, is that students may, at any time, be inputting comments related to different stages of the development of the topic. Not only is the discourse "multi-level" in that several different topics may be in simultaneous discussion, but it is also "multi-speed", in that participants are responding to various phases in the evolving argument, at any one time. A lot of reading and rereading is required to keep a clear structure of the discourse in mind. (Romiszowski & de Haas, 1989).

Another problem originates from the distance communication aspect of CMC. Although distance communication allows one to participate in a discourse which may otherwise be impossible, it also introduces some difficulties of control of the discourse. The instructor loses some of the benefits offered by a face-to-face group situation. When the discussion drifts off the topic, it often takes longer, and is more difficult, to bring the group back on task (Romiszowski and Jost, 1989).

Initial Experiences Using CMC for Instruction

Our own experience in the use of computer-mediated communication as a formal methodology of instruction commenced with a short computer-conference (or rather SEMINAR) which linked up two student groups on similar courses at the Universities of Twente (in Holland) and Syracuse (in the USA). Our interest was in using a simple system (the existing e-mail linkup through Bitnet) but with a greater amount of structure to the interactions, that would replicate certain face-to-face strategies of instruction. It was decided to replicate the SEMINAR structure, as this would seem to be particularly suitable to the characteristics of the system (Romiszowski & de Haas, 1989). Rather surprisingly, the discussion that did take place was quite different from the intentions defined in the initial seminar paper. A retrospective study of the dynamics of the seminar suggests that the initial respondents to the paper, who chose to challenge the basic assumptions, then set the tone for the whole in that later respondents tended to reply to the latest messages on the system, rather than to a general framework for the discussion that was set up in a paper prior to the conference.

Separate analyses of the structure of the discussion were performed, retrospectively, at both Twente and Syracuse, by different participants. One aspect of interest was that the structure was seen to be different by each of the analysts. This finding illustrated the somewhat personal view that each participant developed of the seminar.

The observations described above were the basis for planning a second somewhat larger CMC seminar, held during the months of April and May 1989. This was planned to more closely examine some of the factors that had been observed earlier (Romiszowski & de Haas, 1989). Once more the discussion rapidly drifted away from the expected theme initially defined for the seminar and a coherent view of the seminar's structure was lost.

In May and June of 1989, a third experiment was conducted, this time imposing more precise, course-related structure to the proceedings. The ensuing debate was a much richer and deeper, as well as a much more focused experience. In addition, the depth and detail of this ensuing discussion compares very favorably with that usually obtained in a classroom based seminar session.

We observed, however, that the style of contributions and their length had undergone a significant change. Whereas the messages on the previous occasions were generally short and chatty and directed to one or other of the recently preceding e-mail messages, the responses now became longer, more formal and precisely tied to specific points raised in the original paper.

These differences have both their positive and negative aspects. On the positive side, the intensity of involvement and participation increased. Also, the discussion did not wander disastrously away from the topic initially set. In some eyes, of course, this focusing could be considered a negative aspect, in that it may have limited the exploration of "bright ideas" that were not foreseen in the original author's focus questions. But from an instructional design viewpoint, some focusing (more than was achieved in the previous two experiments) is generally desirable.

Throughout this series of experiments, much attention was paid to the question of how a participant may form and maintain an overall structure of the discourse that is evolving over time. Several methods were used for keeping track of structure. One limitation of this system is that one cannot construct a hierarchical (or any other) structure of notebooks. Any complicated structure must be noted separately, off line.

It is in this context that a Hypertext environment, or shell, into which all messages could be stored in the most fully cross-referencable manner, suggests itself as a possible solution.

Hypertext and Its Contribution to CMC

The collaborative annotation of student papers by both faculty and students is something that many proponents of hypertext advocate and (occasionally) practice. One of the more long-lived working hypertext environments—Intermedia at Brown University—was specifically designed to support this sort of collaborative educational activity (Yankelovich et al, 1988; Landow, 1987).

However, current hypertext systems which can support this type of activity effectively are large, costly, and not easily compatible across different computer systems. The Intermedia system is "built on top of the 4.2 BSD UNIX operating system and runs on IBM RT/PC and Sun workstations which support Sun's Network File System (NFS)" using a special version of the C programming language, and a host of specially developed applications packages (Meyrowitz, 1986). Other powerful and flexible systems, such as NEPTUNE (Delisle et al 1986) are quite different in configuration, but no less complex.

Our current projects are based on the concept of utilizing, as much as is possible, what already exists and is established in significant quantity in the educational marketplace. At this point in time (in USA universities at any rate) the MS-DOS personal computer has the largest market share followed by the Macintosh. Also, many existing e-mail systems operate as networks of existing general purpose personal computers. When used for e-mail, these computers are called on to act simply as dumb terminals linked to the mainframe that supports the communications system. However, it is possible to make use of the presence of local power and memory storage to download incoming mail messages to be stored directly on disc.

In our CMC conference's and seminars using Email, no attempt was made to impose a centralized structure through the system. Indeed, the limitations of the Email systems we have prevented us from doing this. The instructors involved would attempt to define an initial structure in an opening "position paper". We then encouraged each of the participants to map their own view of the emerging structure. Students organized course materials into notebooks that were personally meaningful. Students can also be provided with some basic initial structure which separates course content from personal communications. They can also be given some suggestions for organization. One time-saving aid to understanding and organization is to encourage students to title their responses so that others are able to quickly recognize what the note's content is in response to.

Further organizational tools which help the student in following the often interweaving subtopics, which emerge, is to download and organize messages and to create pattern notes of the topic areas which show the interrelationships that may exist. The students can also benefit by comparing their structures with each other. Instructors can organize related topics, ideas, etc. and send them to students for additional discussion. The students active involvement with the content structure leads to a more meaningful understanding and greater transfer of the new knowledge.

It should be possible to adapt an existing pc-based hypertext environment so that new messages can not only be stored in appropriate subdivisions of the basic structure one creates, but can also be freely cross referenced to other relevant messages. We are investigating the applicability of some currently available and relatively cheap hypertext applications packages for this purpose.

Experiment #1:
Seminars in a HyperCard Environment

A recent experiment involved the use of a networked communication space, set up in Hypercard and running on a Macintosh cluster. Each of the participants in the CMC seminar has a stack of pre-prepared cards, with scrolling text windows, thus giving unlimited writing space, but dividing the text into "chunks", so that each separate issue/topic in the discussion has its own card. These cards can be accessed by all the participants, who can read them, add small annotations and make links to cards in their own stack. As the discussion progresses, a cross- referenced network of documents is created. This facilitates the review of the discussion by a new participant or by someone who has not logged on for some time. It also ensures that new comments are linked to earlier ones on the same topic, as well as making it very easy to review all the contributions of any one participant.

Figure 1 illustrates the home card of the system set up for seven seminar participants. In addition to the seven personal stacks, users have available a short resume of each participant and their phone, fax and e-mail numbers, in case they want to get into touch personally, send a reprint of an article, etc. Clicking on the required icon takes one directly to the first card of that stack. Browsing through that stack, the reader can identify the specific topic under discussion by a label in the top left corner. Figure 2 shows a typical card from one of the stacks. The stack "owner's" comments (in this case on an experiment performed with an expert system) have in turn been commented by another participant, who has registered the card number in his stack where the relevant comment can be found, in the small window below his personal icon. To read the comment, just click on the person's icon and key in the card number. To register a new comment, just type it into one of your own cards and create a cross reference by typing that card's number in your window on the other person's card. Figure 3 shows the comment made by another student on the question in Figure 2. The system was designed by one of the authors, Echeol Chang, specifically so that no learning of hypercard or any complex access commands would be necessary. People are comfortable on the system in a matter of a few minutes.

We are currently using this networked system on campus, in an experiment which is a model for a system that could in future be accessed over telecommunication links from any distance. As the system is conceived as an alternative to e-mail or other readily available CMC systems, we are concentrating on the comparison of these alternatives from the user's viewpoint. We have been using several alternative systems: the system just described and a file-sharing system in which all participants comment a position paper in the same file, but do so by inserting their comments among other related comments. This can be implemented on existing mainframe systems, in our case in CMS. Users have access to a read-only initial file (the paper to be commented) and to a read/write comments file. These can be set up in two scrolling windows, on a split-screen, so that comments can be typed in as the paper is being read. Organization is achieved simply by referring comments to line numbers in the original position paper. This approach has the advantage that it is already widely available, networked internationally through Bitnet or its alternatives. It has the disadvantage that it is clumsy to use and much learning is necessary to become skilled in its use. Surprisingly, however, users do not have much of a problem with the interpretation or generation of comments that are mixed in with other users' comments in one document. We have therefore prepared a user friendly, Macintosh equivalent of this system which we are currently testing in comparison to the networked system described earlier and to the mainframe-based system. Figure 4 shows a typical screen from this system.

All these alternative systems have been used by students to present and discuss their seminar papers. During one semester, each student had to perform a bibliographic research study and a practical evaluation on a selected aspect of new technologies. The results of this work, together with a series of key issues for discussion, were then presented as a seminar paper to the rest of the group. The discussion of the seminar papers took place on one or other of the CMC systems. In all, seven seminars were held, six generated by the students and a final course review seminar set up by the present authors. The characteristics of these seminars were as follows:

1. "Computer Mediated Communication", addressing 8 key issues. Worked as a pair of files on the mainframe (position paper and communal comments space). Set up in CMS and accessible from any campus computer cluster or from home via modem.
2. "Hypertext for Learning", addressing 6 key issues. Worked as as a pair of split-screen scrolling windows in a Hypercard stack (see Figure 4). From the user's viewpoint this configuration was identical to the CMS mainframe-based system, with the added characteristic that each key issue of the position paper, and therefore all the related comments as well, occupy a separate card in the stack.
3. "Expert Systems as Job Aids", addressing 5 key issues.
4. "Optical Videodisc Technology", addressing 5 key issues.
5. "Computer based Simulations", addressing 6 key issues. The last three ran on the hypertext-like network, in which each participant has his/her own workspace in a separate stack (see Figures 1 to 3), but can simply link any card to any other card in any of the other stacks.
6. "Knowledge Acquisition and Representation", addressing 6 issues. Worked as a CMS file on the mainframe, but without scrolling windows. Users simply open space and insert their comments into the original paper at the appropriate place. Each comment is identified

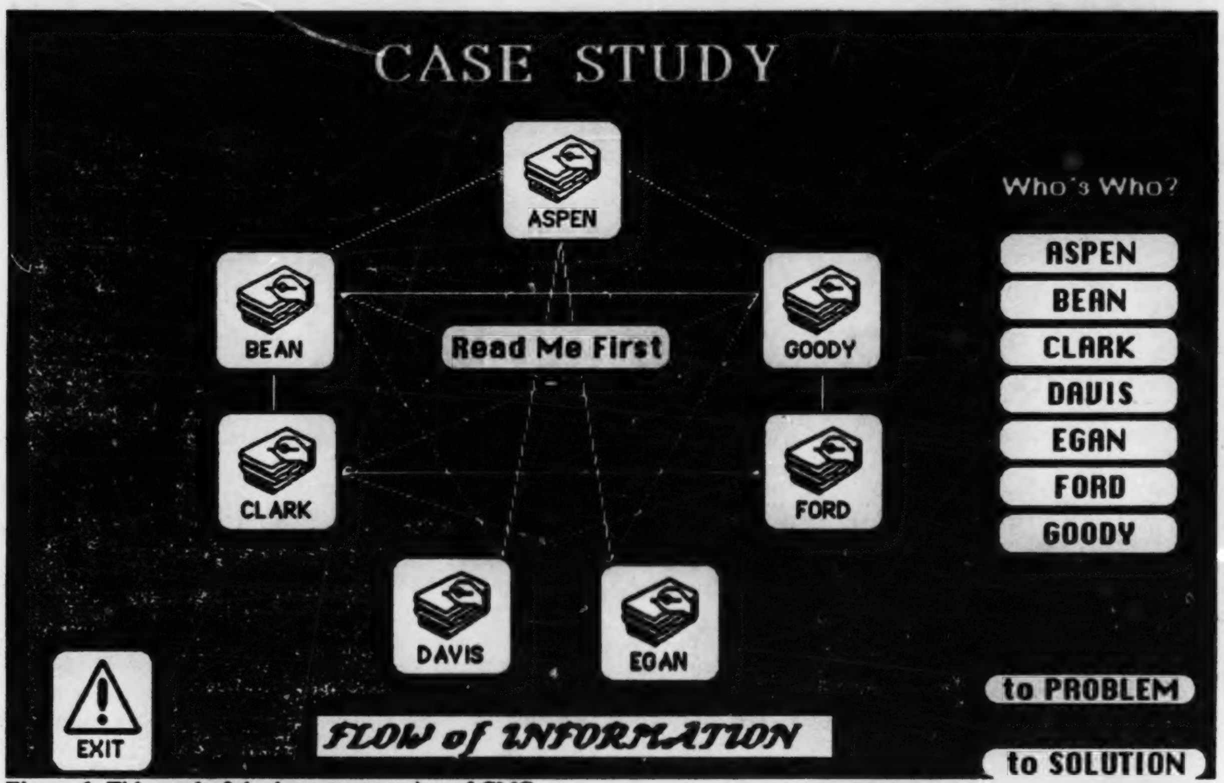
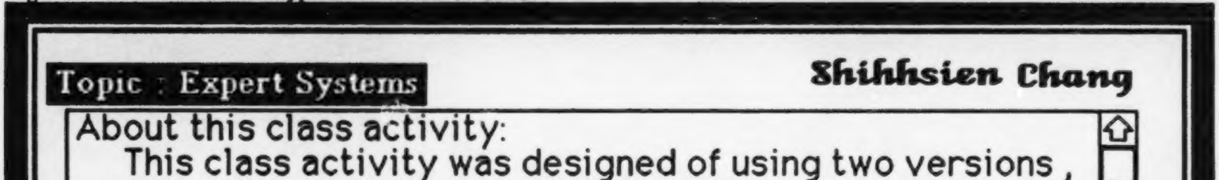

CASE STUDY
ASPEN
BEAN
GOODY
Read Me First
CLARK
FORD
DAVIS
EGAN
Who's Who?
ASPEN
BEAN
CLARK
DAVIS
EGAN
FORD
GOODY
EXIT
to PROBLEM
FLOW of INFORMATION
to SOLUTION

Figure 1. Title card of the hypertext version of CMC.


Topic : Expert Systems
Shihhsien Chang

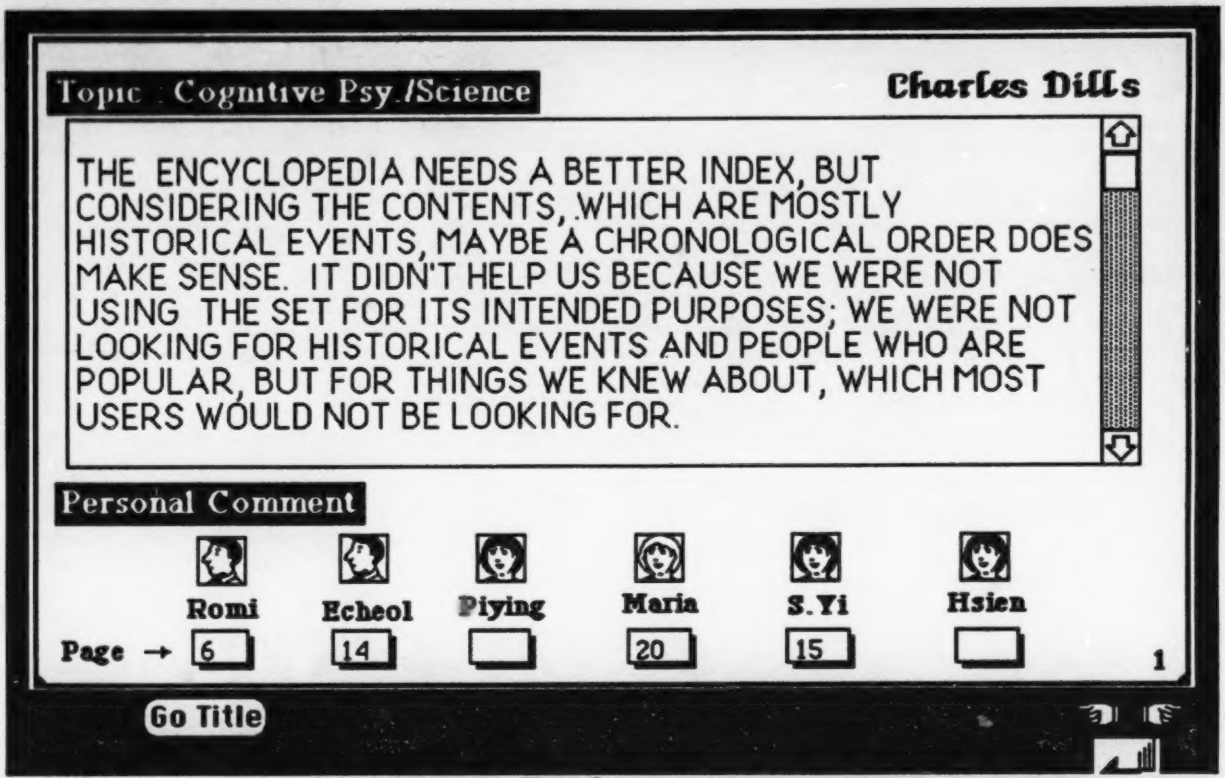
About this class activity:

This class activity was designed of using two versions , machine-based and paper-based of a small expert system call CBT Analyst to get advice of selecting courses for CBT. Four course contents (scenarios) were given to six participants who were devided into two groups, group A and group B. Few statements of course contents were introduced at the beginning of each scenario. Base on the same course content, participants were asked to consult from machine-based or paper-based expert system.

Personal Comment

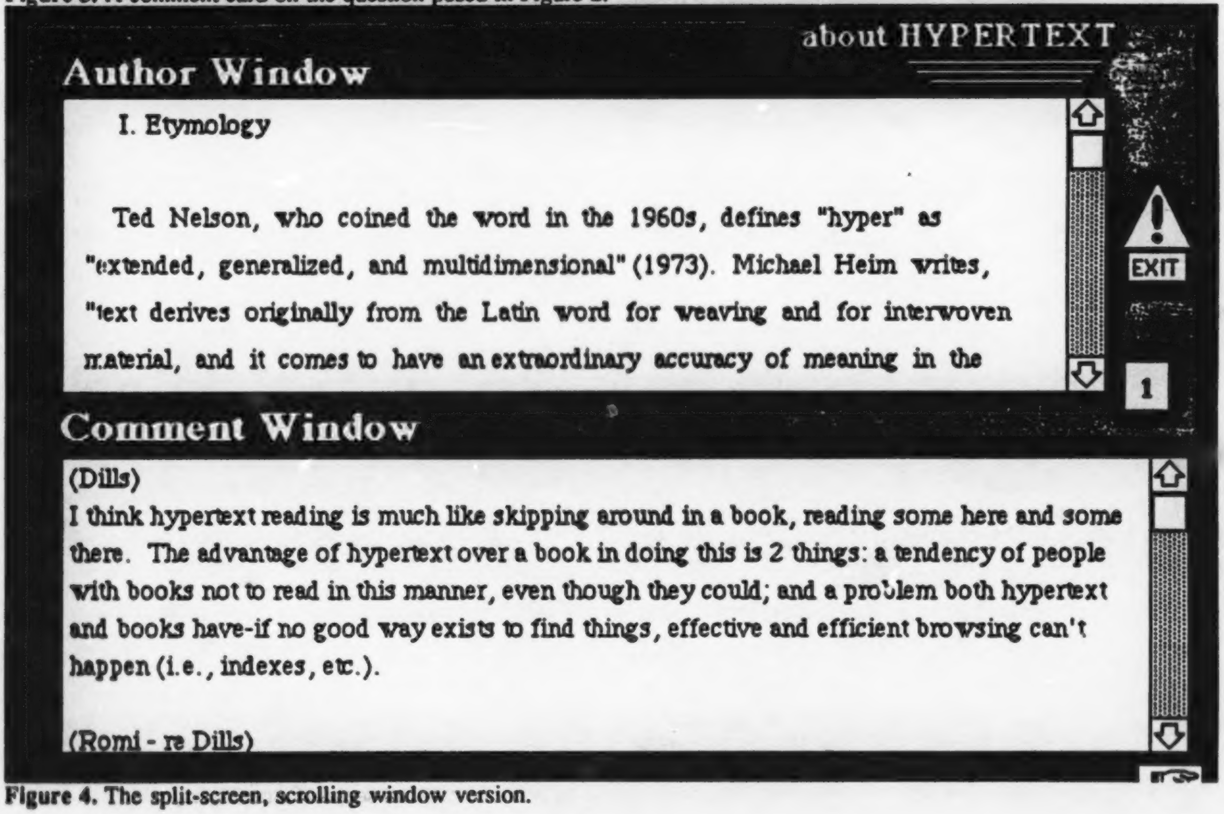
	Romi	Dills	Piying	Maria	S.Yi	Echeol
Page →			7	3	1	12

Figure 2. The fifth card in a seminar on expert systems.


Topic : Cognitive Psy./Science
Charles Dills
Personal Comment
Romi
Echeol
Piying
Maria
S.Yi
Hsien
Page →
6
14
20
15
1
Go Title

THE ENCYCLOPEDIA NEEDS A BETTER INDEX, BUT CONSIDERING THE CONTENTS, WHICH ARE MOSTLY HISTORICAL EVENTS, MAYBE A CHRONOLOGICAL ORDER DOES MAKE SENSE. IT DIDN'T HELP US BECAUSE WE WERE NOT USING THE SET FOR ITS INTENDED PURPOSES; WE WERE NOT LOOKING FOR HISTORICAL EVENTS AND PEOPLE WHO ARE POPULAR, BUT FOR THINGS WE KNEW ABOUT, WHICH MOST USERS WOULD NOT BE LOOKING FOR.

Figure 3. A comment card on the question posed in Figure 2.


about HYPERTEXT
Author Window
EXIT
1
Comment Window

I. Etymology

Ted Nelson, who coined the word in the 1960s, defines "hyper" as "extended, generalized, and multidimensional" (1973). Michael Heim writes, "text derives originally from the Latin word for weaving and for interwoven material, and it comes to have an extraordinary accuracy of meaning in the

(Dills)
I think hypertext reading is much like skipping around in a book, reading some here and some there. The advantage of hypertext over a book in doing this is 2 things: a tendency of people with books not to read in this manner, even though they could; and a problem both hypertext and books have-if no good way exists to find things, effective and efficient browsing can't happen (i.e., indexes, etc.).

(Romi - re Dills)

Figure 4. The split-screen, scrolling window version.

The choice and sequence of CMC systems used were largely dictated by practical and timeline considerations. The last two seminars returned to using mainframe-based systems, as accessibility from anywhere, both on and off campus, proved to be one of the most important student requirements. The alternative system configurations were employed to overcome some of the "user unfriendliness" of the initially used split-screen arrangement. Students were unwilling to go to the trouble of setting up two CMS files as two scrolling windows, on screen at the same time, a procedure that required a sequence of some half dozen commands. Instead, they invariably printed off the position paper and used the hard copy alongside the computer terminal for reference as they worked on the comments file using the full screen display. The last two seminars attempted to facilitate the use of a mainframe-based system, adapting to preferred student working habits (and in the process sacrificing some of the structural features that were originally designed into the experimental CMC systems).

The five alternative systems were compared by observing the students' working habits and interviewing the students on their preferences. Also, some attempt was made to measure the amount and the quality of interactive/collaborative work on the seminars.

In relation to working habits, it was observed that the majority of the students did not actually choose to work on-line. Five of the six course members would generate hard copy printouts of the latest version of the seminar discussion, would study these off-line and compose their comments. Only then would they log on again in order to input the comments. They would do this not only with the mainframe-based files, but also with the Macintosh-based hypertext-like databases. Part of the reason for this may have been that the Macintoshes had to be accessed by going to the School of Education (and often encountering a line of other students waiting to use them). But the students also expressed a preference for working off-line, rather than spending a considerable amount of time peering at a computer screen. In addition, they wished to keep a hard copy of their work, as they did not feel much "ownership" of the communal files in which they were working on these seminars. This was one unexpected aspect of our change from using an e-mail system where each student has a separate account, to a shared account open to all the course participants.

In relation to students' observations, perceptions and preferences, it is worth mentioning the following:

- The majority of the group did not like using the hypertext like environment provided for three of the seminars, mainly because of the extra work involved in clicking on icons in order to move from one card to another. No one had any difficulty in learning or remembering how to navigate around the network, but they resented the need to spend time doing so.
- Also they did not feel that the networked system helped them to form a clearer picture of the structure of the seminar discussion. Whilst some felt that the act of creating links between cards helped them to better visualize the structure of the topic under analysis, most considered that the browsing of a network of cards left them without as clear an idea of structure as seeing all the related comments chunked together in one file. They also felt that there was a time penalty in using the networked system, not so much because of the logistics of moving from card to card, but because they often felt the need to return to a card just to reread it, as it was out of sight as they were trying to compose a reaction to it. Research by Monk et. al. (1988) supports the view that there may well be a significant time penalty in using hypertext documents as compared to scrolling files.
- Among the special benefits of the approach, some students mentioned that the discipline of having to write down one's comments not only records creative observations which would otherwise soon be forgotten, but actually encourages the generation of creative insights into the topic. A second benefit, directly related to the asynchronous nature of the process, was quoted by three of the four overseas students in the group - being able to take one's time off-line, to study others' and compose one's own contributions, goes a long way to breaking down the barrier to participation that is created by incomplete mastery or lack of confidence in using English as a second language. The figures presented in Table 2 bear this out - though the overseas students may have participated somewhat less intensively than the USA students, they have nevertheless all participated, something that seldom occurs in face to face seminar discussions.
- In studying the figures shown in Table 2, it may be helpful to note that the seminars were scheduled at one-week intervals, except for the first one, which ran for a full two weeks before the second one was launched. This may account for the higher level of interaction (comments per student) than the general trend would suggest. Also, the last seminar, being instigated by the professor and having an overall review and synthesis function across several topics previously discussed in earlier seminars, probably generated a higher than average propensity to participate and to respond profusely.
- The figures in Table 2, although based on a relatively small group, do illustrate a very healthy level of participation, particularly in the later seminars. Even in the earlier seminars, the total amount of discussion compared favorably with the amount of interaction generally obtained in a one or two hour face-to-face seminar. As the semester progressed, the level and intensity of participation continued to increase, as shown by the growing figures for "comments made per person per issue addressed" and "length of comments made per person per issue". This latter figure steadily increases till it stands some eight times as high at

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the end of the semester as compared to the beginning. The average comment in the first seminar was two lines long. Mostly, these comments were cryptic agreements/disagreements or questions for further explanation. These in turn called for a lot of time and effort to moderate the seminar and respond to the questions being asked. Note that in the first seminar,the volume of moderators' comments (paper author's and course professor's) were more than double the volume of all the students comments together. This number falls progressively, until finally we are able to eliminate the moderation function altogether.

- What the table 2 figures do not show is why it was possible to reduce and finally eliminate the moderator's role. The quality of the contributions made by the participants progressively improved as they became more familiar with the use of CMC. They became more incisive, more argumentative, more confident in taking issue with another student's contribution, etc. The group became quite able to lead and to moderate its own discussion. Thus the increasing volume of participation during the course of successive seminars, represents a learning process on the part of the participants, developing their own style of print-based discussion. It was particularly gratifying to observe the growth in capacity to offer and to receive constructive criticism, especially on the part of certain overseas students in the group who, in addition to the language inhibitions mentioned earlier, often have strong cultural inhibitions that effectively prevent them from engaging successfully in the give and take of critical analysis of each other's productive thinking.

Experiment #2: The Use of Case Studies in a HyperCard Environment

Over the last few years, we have been developing a range of case materials that can be used for the teaching of instructional design and development skills. In developing these case studies, we are, of course, attempting to practice the technology of case writing and case discussion as it is currently understood. We are also interested in implementing innovations, particularly along the lines of the creation of automated case study exercises that could be used in distance education as well as in classroom based instructional situations.

The instructional design and development case collection covers a wide range of skills that needs to be developed in a practicing instructional designer.

Seminar #/ Title	1 (CMC)	2 Hypertext	3 Expert System	4 Videodisc	5 Simulation	6 Knowledge Engineering	7 Review
# Issues Addressed	8	6	5	5	6	6	9
# Comments Made	59	24	17	23	17	36	79
# Lines of Comment	128	104	96	219	134	310	1412
Avg. Comment Length	2	4.5	5.5	10	8	8.5	17.5
# Comments/ Student	11.8	4.8	3.4	4.6	5.7	7.2	13.2
# Comments/ Std/Issue	1.5	0.8	0.7	0.9	0.9	1.2	1.5
(US Students)	(1.75)	(0.75)	(1.0)	(0.9)	(0.8)	(2.5)	(2.2)
(Overseas)	(1.4)	(0.83)	(0.5)	(0.9)	(1.0)	(0.9)	(1.1)
#Lines/ Student	25.6	20.8	19.2	43.8	44.7	62	235
# Lines/Std/ Issue	3.2	3.5	3.8	8.8	7.4	10.3	26.2
(US Students)	(3.0)	(4.6)	(6.3)	(12.4)	(5.8)	(16.0)	(35.9)
(Overseas)	(3.25)	(2.7)	(2.2)	(6.3)	(8.25)	(8.9)	(21.3)
# Moderator Messages	63	22	5	8	5	3	0
# Moderator Lines	298	143	65	125	63	30	0
Mod/Std Comments (%)	233%	138%	68%	57%	47%	10%	0

Table 2. Data From Initial Experiment with The Hypertext Discussion Environment.

One particular skill area of great importance is what we term front-end analysis. This is the analysis that ought to be performed in order to ensure that a particular training project really starts off on the correct lines. Several cases have been developed to help our students learn these skills in a practical context. One of these cases will be used here as an example of the general approach we are using.

The readers are invited to imagine that they have been called to bid on a project by a local university that has perceived a problem in the area of the skills of its faculty members. You arrive to an initial meeting where you are briefed on the background to this supposed problem. You learn that the university has invested quite heavily over the last few years in a variety of audiovisual aids, among them a large number of overhead projectors, one of which has been installed permanently in every teaching space of the campus. A recent survey has shown that since this has occurred, very little increase in the use of the overhead projector has in fact taken place. Very few faculty members ever use the overhead projector at all, and incidentally many of those who do use it use it ineffectively or badly. The screen cannot be seen from certain parts of the room; the incident lighting is badly organized; the transparencies are so prepared that they are illegible, etc. You are being invited to 'teach our faculty to use the overhead projector and to use it well'.

In the past, this situation would be developed as a role play exercise in the classroom, a number of typical "stakeholders" in the problem and interested parties being represented by the professor and assistants. The students on the course could interview several faculty members, the audiovisual department employees and gather whatever data they felt was necessary in order to better understand the problem, its underlying causes and therefore evaluate to what extent the training that's being requested could solve the real problem. All of this information would then be used as a basis for the preparation of a recommendation to the client on what really should be done about the problem. The process of generating this recommendation would, in the classroom implementation, be carried out by small group discussions and seminar-like reports to the rest of the group. Here we have a typical and fairly classic use of the case methodology in the classroom situation.

In preparing a case like this for publication, we face two problems. First, the data gathering stage of interviewing faculty and other interested parties is a very dynamic student led exercise when performed in the role play context as described above. When this is transformed into written case materials, we have the transcripts of discussions/interviews with a variety of people, which have to be read at length by the student and in this process all the student-directedness of the activity is lost. The skills of case writing come into play in order to write scenarios that don't give the game away too much and yet which do include all the information that students are expected to utilize as a basis for their recommendations to management. The second problem is connected with the case discussion. Most published case materials do not actually instrument the discussion but restrict themselves to the case description, the data, and the setting of some problems for discussion. The discussion organization or implementation is up to the leader of the case discussion in the classroom situation. If the case is being studied individually by a reader of the text, then it's really up to the reader to organize it for him or herself. Our interest in some of the case studies we have been developing is to take the instrumentation through to the case discussion stage.

To do this, we turned to a methodology developed first in the United Kingdom in the late 60's and early 70's and called Structural Communication. This was an attempt to create a discussion environment for open-ended self study of topics where multiple viewpoints and various possible correct responses were the rule. The methodology was applied in many different contexts during the early 70's including an experimental correspondence course in the Harvard Business Review, where a Harvard case was discussed by readers responding to a pre-structured programmed exercise (Hodgson and Dill, 1971). Most of these early implementations were in the form of paper text-based self-study exercises, but some used mainframe computers as a delivery medium. With current technology, the Structural Communication methodology has become a powerful and very practical approach to the authoring of conversational CAI tutorials (Romiszowski, Grabowski, and Pusch, 1988).

The components of a structural communication study unit as first formulated by Bennett and Hodgson (Hodgson, 1974) are the intention, presentation, investigation, response matrix, discussion guide, discussion comments, and finally viewpoints (see Figure 9). Each of these plays a part in engaging the reader in a deep analysis of the problem that has been presented. In our case, the intention and presentation were taken care of by the case description.

The response matrix was an array of 20 well known approaches to the solution of job-performance problems (See Figure 10). The decision-making model used in this exercise is based on the heuristics for front-end analysis suggested by Romiszowski (1981). The student can select any combination of items. The number of different possible responses that a student can make are very large, in fact, running into the millions. If one restricts oneself to plausible responses, the number may be a lot smaller but still very large. Analysis of the various response patterns is prepared in advance by the authors of the exercise on the basis of significant inclusions or exclusions of items. ote that this analysis is the "script" from which a case study decision leader could speak if discussing the particular discussion "live" or alternatively from which an author could work in order to write some pre-prepared comments to further elucidate and discuss particular aspects of a given student's response to a given problem. This latter approach was used in our work, producing a set of several dozen pre-prepared comments that would be directed in different combinations to different students, depending on how they responded. The style of these pre-prepared comments is open ended and encourages reflective thought rather than the correction of wrong responses. We may say that we are attempting to provide constructive comment rather than corrective feedback.

The implementation of such case studies in an electronic format is desirable for at least two reasons. Firstly, this will overcome some of the utilization difficulties that extensive use of such an interactive methodology has when implemented in a paper format. Secondly, electronic implementation of such exercises should enable one to open them up for student generated comment and input in a way that a published and printed version can never do. By the combination of electronic computer mediated communication with the electronic storage of the basic case-study materials, it should be possible to create an exercise which, in the initial stages, presents authors' prepared views and comments and then allows students to comment those comments and actually converse with the author, although that author may be located somewhere at a distance. Current research that we are engaged in at Syracuse University is exploring the viability of this approach. We have developed some computer software that can implement the Structural Communication methodology, in Hypercard on the Macintosh computer and also more simply on mainframe systems that can be networked worldwide if necessary.

We shall use the Macintosh system here as an illustration because of its better visual qualities. The case study mentioned above has been implemented in Hypercard, the data gathering stage and the problem solution stage being handled by two separate pieces of interlinked software. For data gathering, we have employed the previously developed Hypertext environment, where information about the problem that was posed in the case is stored as a network under student control. By doing this, we are avoiding the degradation of the role-play exercise when presented as printed transcript, because the student is still required to decide what type of information he or she thinks is pertinent and follow this through as a trail from one card to another in the "maze" of information that has been created about the background to the case. Students can, if they insist, read all the information in the data base in a more or less linear sequential way. However, this would be very time consuming. Most students choose to follow particular trails through the network of information, and in order to do this usefully, are forced to formulate in their minds the question that they are trying to follow up before they actually start doing any reading.

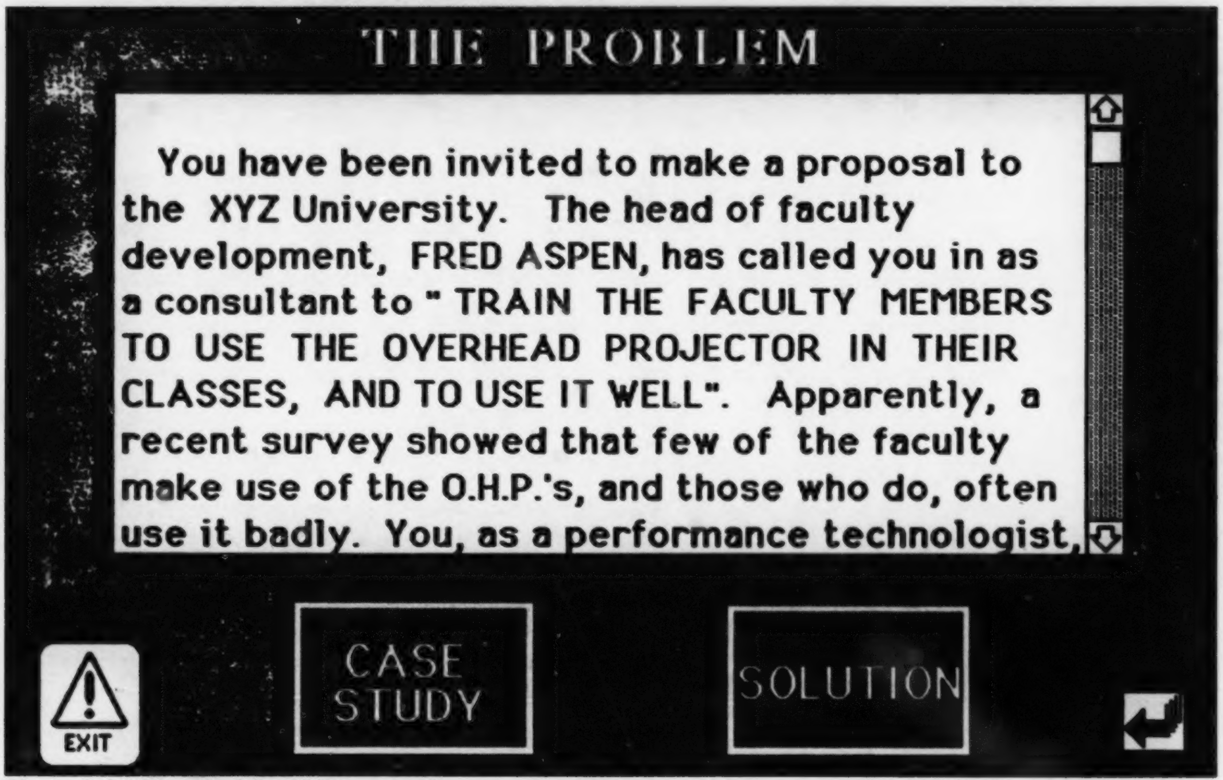
Figure 5 illustrates the problem that has been set and shows how a student can go either to the solution or to the case study sections at will. Figure 6 shows the front card of the case study section which introduces the student to 7 key figures who can be interviewed and also to the resumes of these 7 people (stored in the "who's who" cards indexed along the right hand side of the screen). By clicking the mouse on any of the "who's who" cards, the student can open the resume of that particular person and get a general idea of what their function is in the university, etc. By clicking on the name of that person on the star shaped diagram in the middle of the screen, the student opens a conversation with that person which is presented over a number of cards in a stack. Each of the cards, however, deals with a particular issue, some of these issues being relevant and others irrelevant to the solution of the problem that was originally posed. Figure 7 shows a typical card, in fact one from the interview with the client.

The scrolling window in the upper part of this card contains the transcript of a discussion between the analyst and the particular person being interviewed. At the bottom of the card, there are a series of icons that enable this card to be linked to relevant cards in the interview stacks of all the other six available participants in this automated role play. We note that there is relevant information in card 3 of the stack named "Bean" and also in card 7 of the stack named "Egan." The student immediately knows that relevant trails of inquiry can be commenced by clicking onto those stacks. If the student considers the card currently being read as supplying information that is important for the solution of the problem, then this would suggest following trails to other relevant information at that point in order to immediately formulate a position in regards to that aspect of the problem. If on the other hand the student feels that the issue being dealt with on the current card is not very relevant to solving the problem, then a lot of reading can be avoided by not clicking on the subsidiary cards and indeed continuing directly to another card on a different aspect of the problem altogether. This inquiry environment created by a network of information cards is an attempt to give back to the student the control over what questions to ask and what information to follow up.

When the student has gathered as much information as he or she thinks is relevant and has formulated a clear idea of what are the underlying causes of the problem and what solutions may be most appropriate, a click on the button labeled "solution" takes the student to another part of the software which is prefaced by a card entitled "Structural Communication" (See Figure 8). The student can at this point click on other buttons which give some background to structural communication methodology and how to use it as a learning device. One of these cards is shown in Figure 9. The main button, however, that a student should click on is the one labeled "exercise," for a presentation of the response matrix. The response matrix for this particular case is shown in Figure 10. This presents a total of 20 types of solutions that could be applied in some combination to the problem that the case has posed. The student can select any combination of these

20 by clicking on the appropriate buttons. The choice made appears at the bottom of the card.

Once the student has responded, the program analyzes this response and presents an index to the comments available plus a suggestion of which of those comments may be appropriate for that particular student to read. This is presented on a card illustrated in Figure 11 which acts as the discussion guide for the remainder of the exercise. The student can now click on any of the icons and go to the related comments. Note that the student is not restricted to clicking on those comments which are diagnosed as being appropriate but can look up any of the comments that are available. However, those that the author considers as appropriate to the way the student handled the problem would be the ones that normally the student would read first. On clicking any one of these, the student will automatically be taken to a comments card like the one illustrated in Figure 12. Here there is a scrolling window in which the author's comment is presented. Figure 12 shows a comment generated by the student NOT including item Q from the response matrix (Figure 10). Note that there is no physical restriction on the length of this comment. It can be very much more than one screen of text if that is required. Note also that the style of the comment is open ended. It takes the student beyond the exercise in order to reflect more deeply about the implications of the particular position that has been adopted.



THE PROBLEM

You have been invited to make a proposal to the XYZ University. The head of faculty development, FRED ASPEN, has called you in as a consultant to " TRAIN THE FACULTY MEMBERS TO USE THE OVERHEAD PROJECTOR IN THEIR CLASSES, AND TO USE IT WELL". Apparently, a recent survey showed that few of the faculty make use of the O.H.P.'s, and those who do, often use it badly. You, as a performance technologist,

Figure 5. Initial card of the OMP case study.

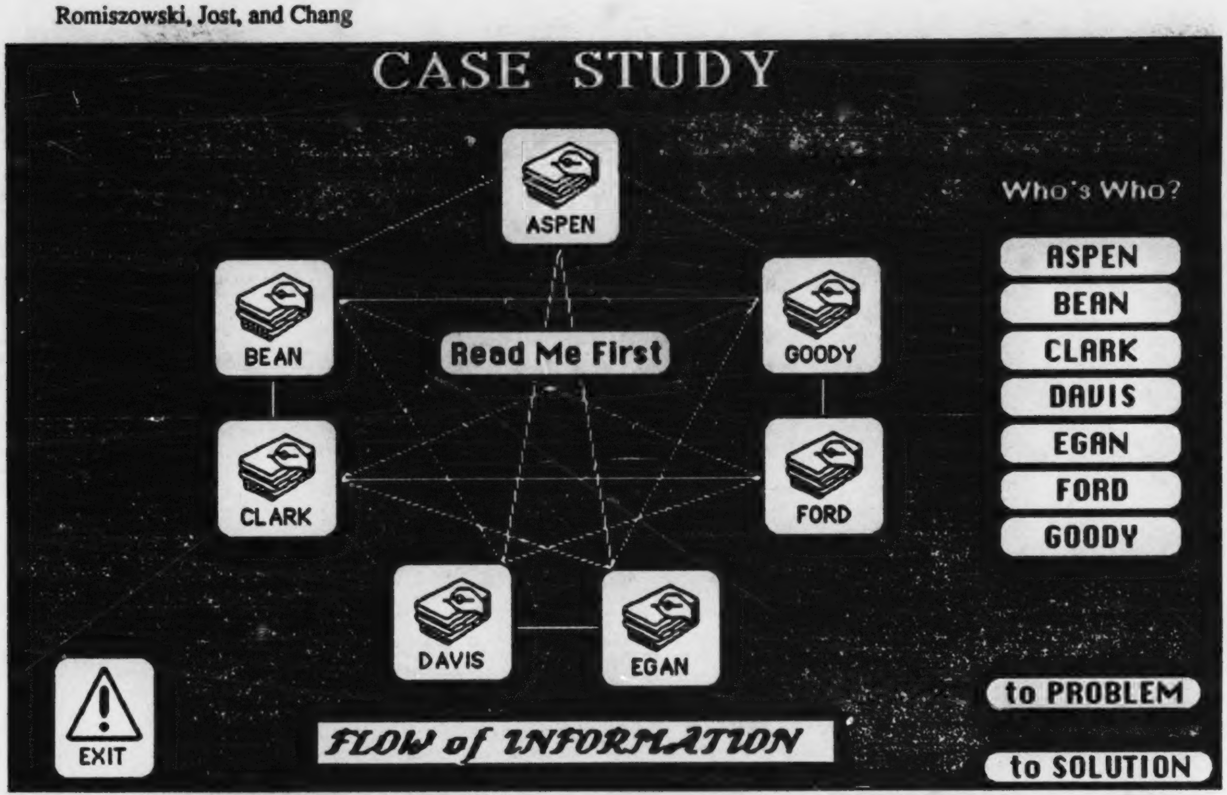
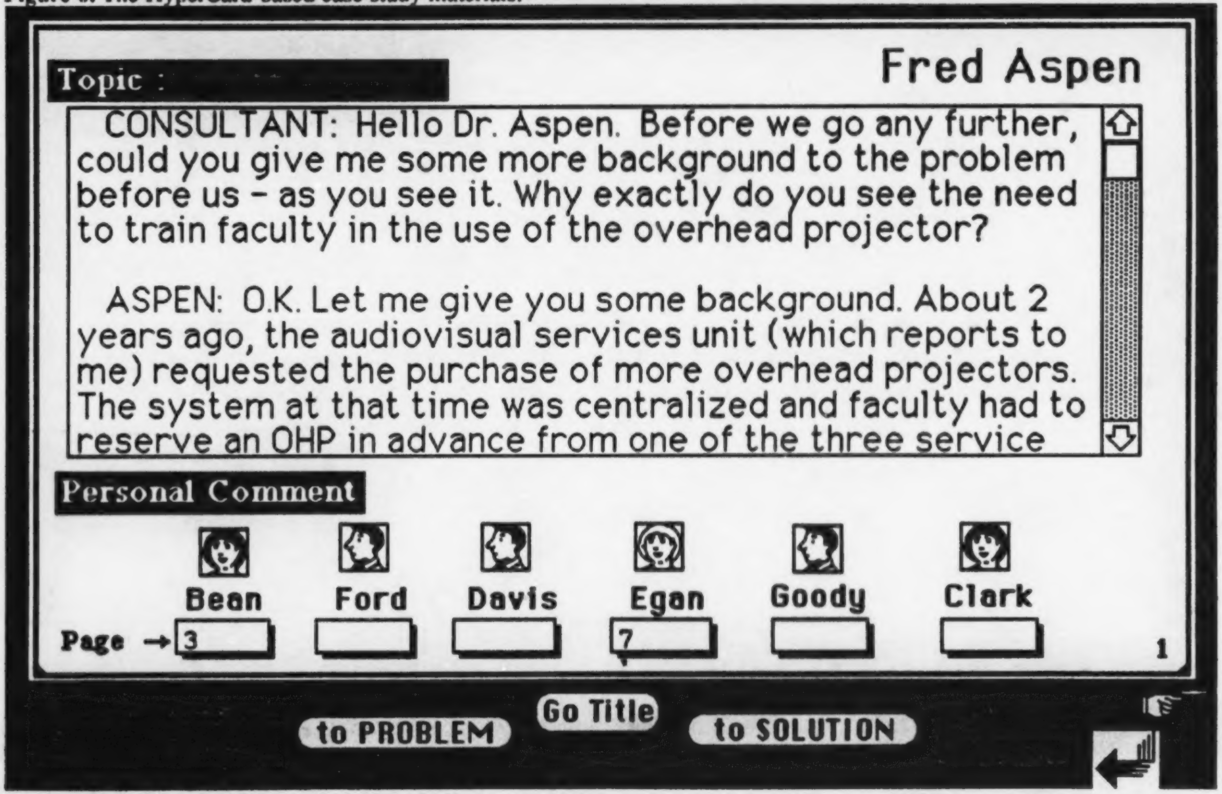

CASE STUDY
ASPEN
BEAN
GOODY
Read Me First
CLARK
FORD
DAVIS
EGAN
Who's Who?
ASPEN
BEAN
CLARK
DAVIS
EGAN
FORD
GOODY
EXIT
FLOW of INFORMATION
to PROBLEM
to SOLUTION

Figure 6. The HyperCard-based case study materials.

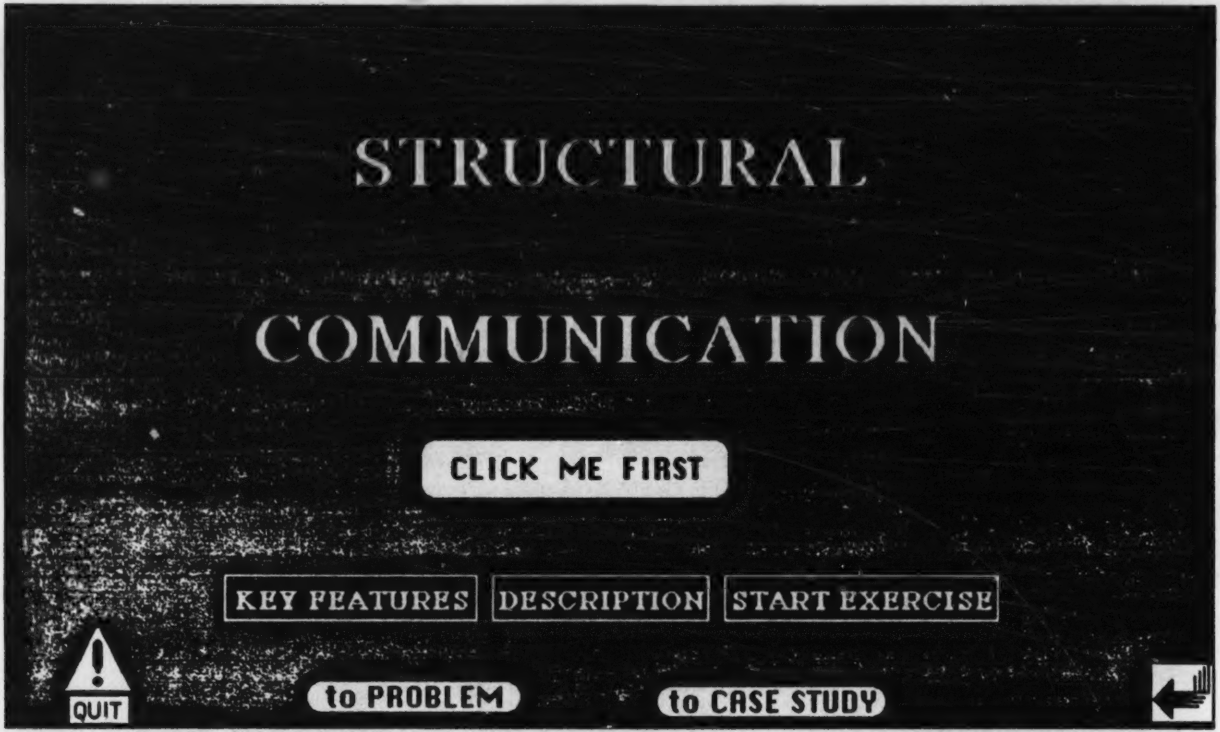

Topic :
Fred Aspen

CONSULTANT: Hello Dr. Aspen. Before we go any further, could you give me some more background to the problem before us - as you see it. Why exactly do you see the need to train faculty in the use of the overhead projector?

ASPEN: O.K. Let me give you some background. About 2 years ago, the audiovisual services unit (which reports to me) requested the purchase of more overhead projectors. The system at that time was centralized and faculty had to reserve an OHP in advance from one of the three service

Personal Comment
Bean
Ford
Davis
Egan
Goody
Clark
Page →
3
7
1
Go Title
to PROBLEM
to SOLUTION

Figure 7. Typical card from an interview script.

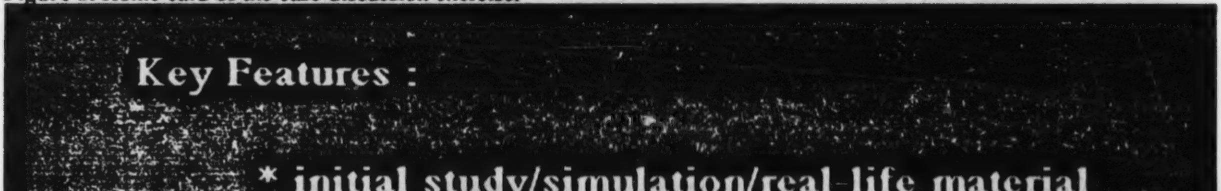


STRUCTURAL

COMMUNICATION

CLICK ME FIRST
KEY FEATURES
DESCRIPTION
START EXERCISE
QUIT
to PROBLEM
to CASE STUDY

Figure 8. Home card of the case-discussion exercise.



Key Features :

* initial study/simulation/real-life material

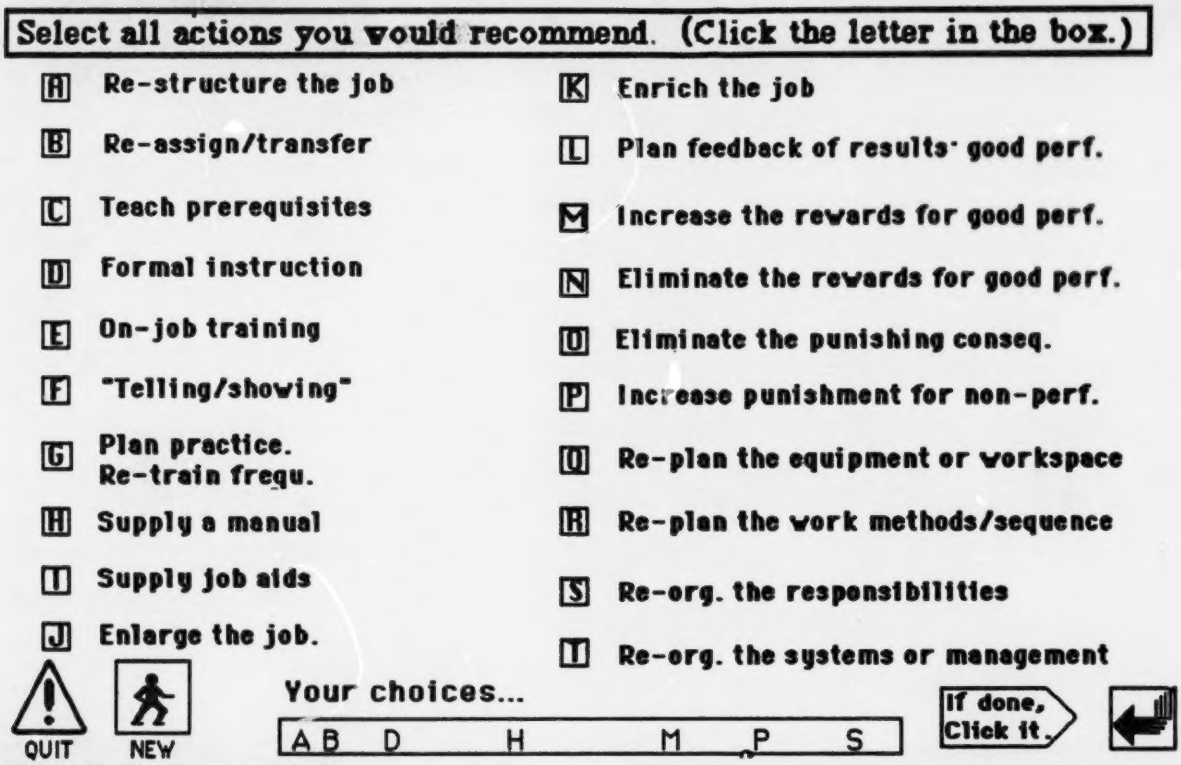
* problem sets

* response matrix

* discussion guide

* discussion comments

Figure 9. The components of a Structural Communication exercise.



Select all actions you would recommend. (Click the letter in the box.)

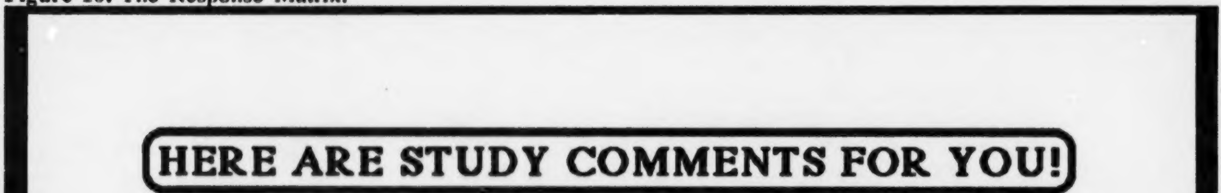
A Re-structure the job
B Re-assign/transfer
C Teach prerequisites
D Formal instruction
E On-job training
F "Telling/showing"
G Plan practice. Re-train frequ.
H Supply a manual
I Supply job aids
J Enlarge the job.
K Enrich the job
L Plan feedback of results· good perf.
M Increase the rewards for good perf.
N Eliminate the rewards for good perf.
O Eliminate the punishing conseq.
P Increase punishment for non-perf.
Q Re-plan the equipment or workspace
R Re-plan the work methods/sequence
S Re-org. the responsibilities
T Re-org. the systems or management

Your choices...

A B D H M P S

QUIT
NEW
If done, Click it.

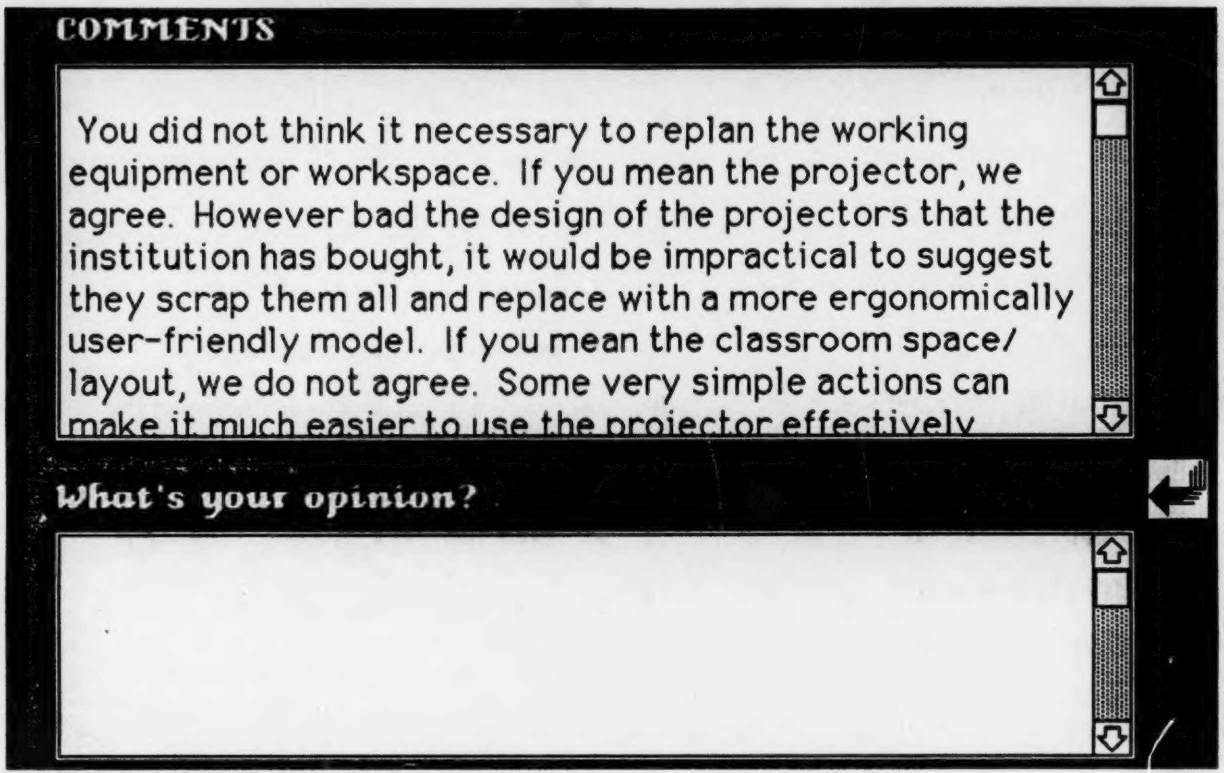
Figure 10. The Response Matrix.



HERE ARE STUDY COMMENTS FOR YOU!

Click it
Click it
Click it
Click it
Click it
Click it
Click it
Click it
Click it
NEW & PRINT

Figure 11. The Discussion Guide



You did not think it necessary to replan the working equipment or workspace. If you mean the projector, we agree. However bad the design of the projectors that the institution has bought, it would be impractical to suggest they scrap them all and replace with a more ergonomically user-friendly model. If you mean the classroom space/ layout, we do not agree. Some very simple actions can make it much easier to use the projector effectively

Figure 12. One of the 13 Discussion Comments

Note particularly, however, that the card presents a second scrolling window, entitled "Your Comment," in which the student can type in any message to the author requesting further information, registering disagreement with the author's views or whatever comes to mind. This facility allows a discussion to go a stage beyond the original structural communication type of exercise. In the Macintosh implemented version, these comments are stored in their respective cards and can be browsed by the author or indeed by other participating students. Very often a student may make a comment which is prompted not only by the author's viewpoints but also by viewpoints that have been put in by a previous student. In this way, a discussion gets going. The discussion develops at a deep level, beyond the initial analysis of the case material.

In the mainframe implementation of this system, which is planned to be used in distance education contexts, the student comments are automatically E-mailed to the author, or to the course organizer/tutor, wherever he or she may be. The tutor would then reply directly on E-mail to the student, thus developing a discussion on the question that was raised. The present implementation only allows for a discussion between individual students and the tutor-at-a-distance, but by a simple modification, this discussion can be opened up, if desired, to all students.

It is too early to be able to report any conclusive research data. However, initial observations indicate that the Structural Communication methodology is very acceptable to students and can lead to a depth of discussion which rivals the best group discussions that can be achieved in a classroom-based case study session. Of particular interest is the finding that students, or student groups, who normally participate very little in classroom discussion, for example certain groups of foreign students inhibited by their poor English or by cultural factors, participate just as actively in this methodology as any other student. Another observation of note is that the total number of comments, the depth of these comments, the variety of these comments is several times greater than would normally be achieved in the time that could practically be given to classroom discussion of a case study of this nature.

Finally, we are investigating just how time consuming and difficult the task of the tutor becomes in this sort of system, given that every student can, in theory, maintain an individual discussion for as long as he or she wishes with the tutor. The tutor ought to be in a situation where he or she can respond adequately to every student and not leave them "hanging in the air" as it were. In one implementation of the mainframe-based system that ran for several weeks recently, one tutor was handling over 100 students working on management information system case studies. The particular tutor involved habitually uses electronic mail for communication with her students and habitually deals with somewhere in the region of 300 personal messages per week. The implementation of the case studies did not reduce the number of messages dealt with, indeed increased the total number somewhat. However, an analysis of the messages showed that a large proportion of them were messages about the methodology and generally favorable to the methodology. The subset of messages that were second level and third level discussions of the content of the case study were significant but did not form the majority of the total messages. We are therefore hopeful that we are in a position to develop a methodology which, in comparison with other email-based computer conferencing systems, actually reduces the load for the discussion moderator while at the same time increasing the amount of participant discussion and also the depth of that discussion.

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TRAINING FUTURE EDUCATORS FOR INTEGRATED DISTANCE EDUCATION WORKSTATIONS

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Abstract

This paper will describe how future instructional designers are trained at the Department of Educational Technology, San Diego State University to use integrated data-voice-video desktop workstations for distance education. Characteristics of converging technologies will be examined in light of recent technical changes. It will be demonstrated how students use HyperCard to create authoring templates for seven different distant instructional strategies and use Timbuktu for delivering instruction on integrated workstations. Also, it is described how students investigate and analyze selected topics related to current theories, research methods, evaluation strategies and current issues in distance education.

Converging Technologies

Marriage of computer, video and telecommunications technologies have provided a unique and unprecedented opportunity for reaching and serving learners, regardless of time or geographical considerations. As computers proliferate in the workplace, at home and in schools, trained educators who are familiar with theoretical and practical aspects of converging technologies will be in demand for designing instruction for integrated systems. Trained professionals will be needed to:

- Design programs based on current distance education theory,
- Develop programs for converging technologies,
- Use converging technologies to deliver instruction,
- Provide support services to distant learners, and
- Conduct evaluation and research studies on distance education concepts, models and programs.

In the Department of Educational Technology at San Diego State University, students are learning how to use an integrated desktop workstation, based on a Macintosh computer, to design, produce and present telelessons. In EDTEC 700, ***Seminar In Educational Technology: Distance Education***, (Seidman, 1989) students use HyperCard to create authoring templates and Timbuktu to present telelessons. Course objectives include:

1. Name various parts of a typical integrated desktop workstation and describe the function of each part.
2. Develop a script to reflect instructional strategy, content, medium, instructor's role; learner activities; and learner queries in a telelesson.
3. Select appropriate micro design variables (fonts, graphics, sounds, visuals) for a telelesson.
4. Use a desktop workstation to log on and establish basic *voice*, *text* and *video* telecommunications with another desktop workstation.
5. Develop a HyperCard stack and *share* the stack with another user on a desktop workstation.
6. Use a desktop workstation to send and receive instructional information.
7. Develop and present a telelesson via Timbuktu and HyperCard.

Hardware Configuration

With the use of a newly developed integrated workstation, students learn how to communicate via data, voice, text, graphics and video with their learners in a laboratory environment (Saba and Twitchell, 1988).

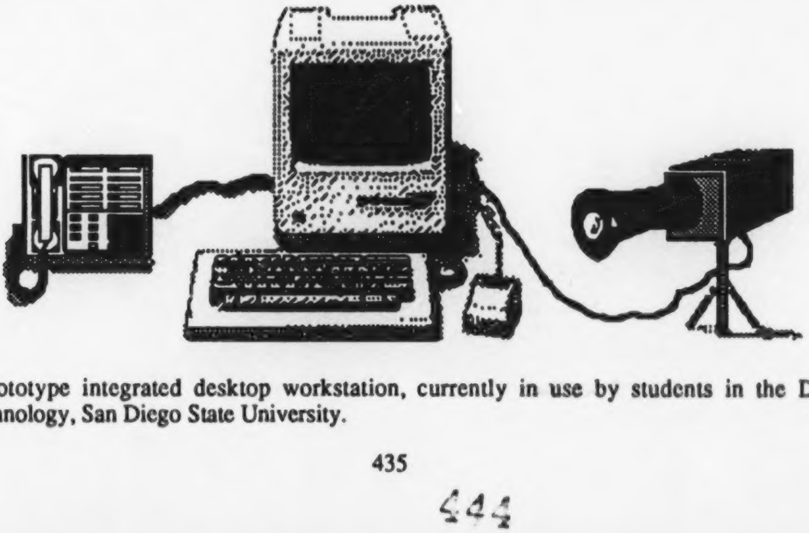

Figure 1. A prototype integrated desktop workstation, currently in use by students in the Department of Educational Technology, San Diego State University.

The teacher and the learner can talk to each other; work on the same computer file (screenshare), exchange data; and with the expansion of broadband telephony, eventually, see each other.

Figure 1 shows a prototype integrated workstation, currently in use by students in the Department of Educational Technology at San Diego State University. The instructor workstation is consisted of a telephone with a speaker to provide hands-free operation, a black and white video camera, a video monitor (not shown in Figure 1, as it is expected that the video and the computer screens converge in a near future) and a Macintosh SE/30. The instructor workstation can be augmented with a video playback unit to show video clips to the learner. The leaner workstation is identical to the instructor workstation, except that it does not include a video playback unit. The instructor and the learner workstations are connected by hard wire. This, however, dose not affect teaching of instructional design principles for integrated systems, as the wiring is transparent to students and future integrated telecommunications systems are effectively simulated with existing technology. Thus, with a relatively inexpensive prototype system students are trained to use a technology which is bound to become popular in the 1990's.

Software Configuration

Those students who have completed at least one course in three areas of instructional design, educational broadcasting, and hypermedia production can enter the course. Through a series of demonstrations and laboratory exercises, students receive hands-on instruction on how to use the voice, video and computing features of the desktop workstation; and establish and maintain communications with at least one remote desktop workstation. As students are already familiar with the use of HyperCard (Allen, Dodge and Saba, 1990) and have learned how to produce and use video clips in prior courses, they can quickly learn how to use the desktop workstation for establishing bi-directional and synchronous communications with their learner working at a remote desktop workstation. The only new feature to them is Timbuktu, a communications software that enables the instructor to share his/her hard disk drive with the learner for a variety of different computing purposes, including screen-sharing and file transfer. Timbuktu is a user friendly software and its use becomes transparent to both the instructor and the learner after a few minutes from initial exposure.

Once students have become familiar with basic communications and computing features of the workstation, they form groups of three to five. They are introduced to seven instructional strategies to produce a HyperCard template for designing, developing and presenting telelessons; or for managing on-line instructional systems. These strategies are:

- Expository instruction,
- Coaching,
- Tutoring,
- Counseling,
- Problem solving,
- Cooperative learning,
- Building an electronic community, and
- Managing the instructional process.

Within the confines of these design strategies, students are encouraged to use their creative talents to include features in the template that would help them to strike an appropriate balance between *dialog* and *structure*, (Moore, 1983; Saba, 1988) as well as to maintain good communications with learners for administrative and counseling purposes. Figure 2 shows a card of a sample stack created for authoring of an expository telelesson. Figure 3 shows the menu of a HyperCard stack created for the management of an on-line instructional system.

Authoring templates are presented in class by each group. Students receive feedback from their peers and the instructor on strengths and weaknesses of each approach. Once the templates are refined, each student selects a content area, or an administrative/counseling procedure for designing, developing and presenting a telelesson; or an administrative procedure. Final projects are delivered "live" and on-line as students teach their learners a combination of facts, concept, procedures, rules, principles or theories related to the selected content area. As students are free to experiment with a wide variety of content areas, final projects have ranged from teaching techniques of shot composition with a video camera, to administering acupuncture. Final projects are evaluated by the instructor as each student delivers his/her program. The evaluation form contains criteria related to macro instructional design, micro design (text, graphics, audio, video), establishing and maintaining technical communications, balancing dialog and structure and evaluating the learner.

Distance Education Theory

In addition to preparing students to use integrated telecommunications systems, the course is designed to develop students' analytical skills for developing a comprehensive understanding of current theories, research methods, evaluation strategies and current issues in distance education. During class lectures several issues related to the impact of "information society" on learning, training and schooling; characteristics of converging technologies; conceptual significance of converging technologies for interactive, synchronous learning; and current trends in distance education theory are introduced. Based on class lectures, a set of reading materials (Moore and Clark, 1989) and other publications each student selects an area of interest for investigation. Students receive individual consultation by instructor as they proceed in collecting information about their topics. Towards the end of the semester, each student makes an oral presentation to the class, based on a written report.

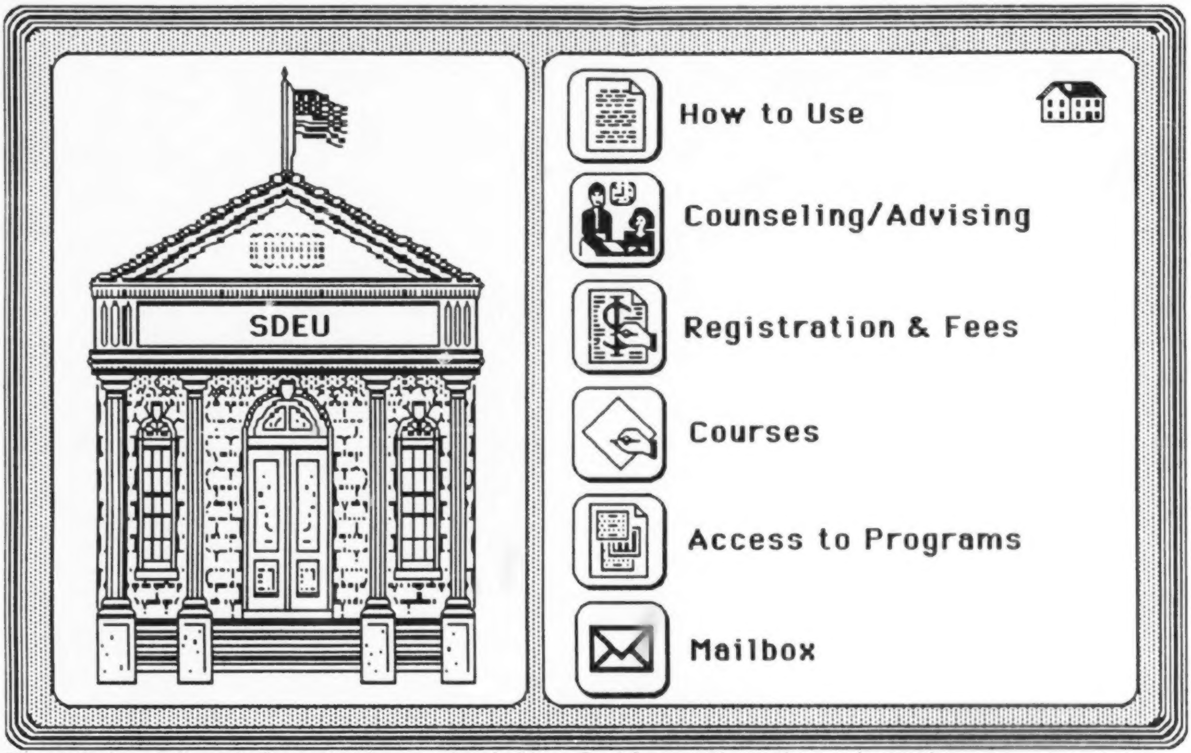

Figure 2. A sample card of an authoring template in HyperCard for expository distance instruction.

Presentations are followed by class discussion. In the past two years, students have studied a variety of topics ranging from concepts of distance education, distance education organizations and distance education in the international arena to future technologies and telecomputing.

Response to the Course

EDTEC 700, has been offered on an experimental basis for the past tow years. Each year, students have received it with enthusiasm, dedication and hard work. They feel they are contributing to the future development of the field of distance education by developing and presenting demonstration projects on a new technology. Because of its success, the Department is currently considering the adoption of the course on a regular schedule.

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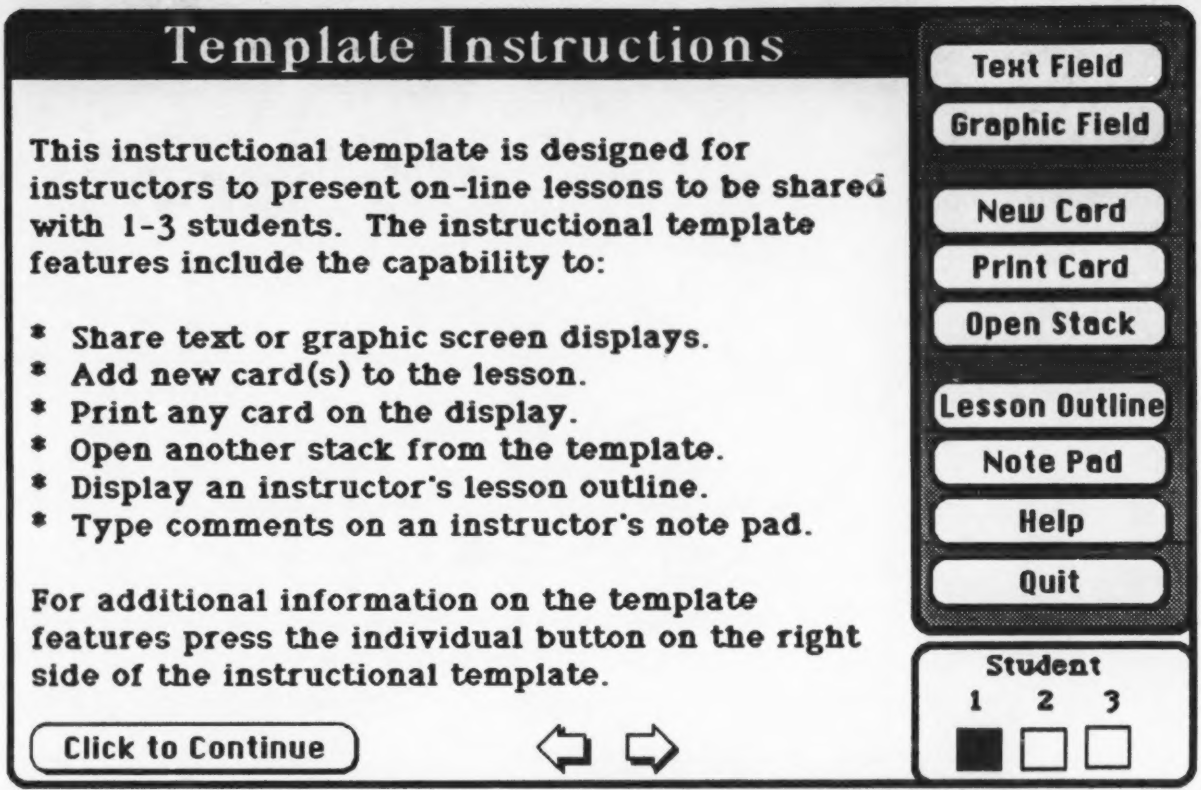

Template Instructions

This instructional template is designed for instructors to present on-line lessons to be shared with 1-3 students. The instructional template features include the capability to:

- Share text or graphic screen displays.
- Add new card(s) to the lesson.
- Print any card on the display.
- Open another stack from the template.
- Display an instructor's lesson outline.
- Type comments on an instructor's note pad.

For additional information on the template features press the individual button on the right side of the instructional template.

Text Field
Graphic Field
New Card
Print Card
Open Stack
Lesson Outline
Note Pad
Help
Quit
Student
1 2 3
■ ☐ ☐
Click to Continue

Figure 3. Main menu of a HyperCard stack created for management of a prototype on-line instructional system.